INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

YGL BULLETIN

NO. 21

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IFYGL

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INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

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NO. 21

November 1977

UNITED STATES

DEPARTMENT OF COMMERCE

DEPARTMENT OF DEFENSE

DEPARTMENT OF INTERIOR

DEPARTMENT OF TRANSPORTATION

ENVIRONMENTAL PROTECTION AGENCY

NATIONAL SCIENCE FOUNDATION

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CANADA

DEPARTMENT OF FISHERIES AND ENVIRONMENT

DEPARTMENT OF ENERGY, MINES AND RESOURCES

ONTARIO MINISTRY OF THE ENVIRONMENT

ONTARIO MINISTRY OF NATURAL RESOURCES

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CONTENTS

CANADA AND UNITED STATES

IFYGL BULLETIN SERIES

This is the last IFYGL Bulletin to be published in the format of progress reports on IFYGL tasks, since all these tasks have been either completed or are nearing completion. There will be a special edition of the IFYGL Bulletin containing summary results of the IFYGL Wrap-Up Workshop to be held in October.

IFYGL WRAP-UP WORKSHOP

The IFYGL Wrap-Up Workshop will be held on October 2-5, 1977, at the Geneva Park Conference Centre, Longford Mills, Ontario. This will bring together the IFYGL panel members, the Joint Steering Committee, and the Joint Management Team for a final meeting.

The purpose of the Workshop is to review accomplishments, to identify priority research programs, and to develop recommendations for future research.

IFYGL SUMMARY SCIENTIFIC REPORTS

It has been the stated intention of the IFYGL Steering Committee and the Joint Management Team to bring together a final overview in depth of the IFYGL programs in what was originally termed the IFYGL Final Scientific Report Series. For this purpose the following titles and authorships were established:

The Terrestrial Water Balance of Lake Ontario and Its Basin
B. G. DeCooke and D. F. Witherspoon

The Energy Balance of Lake Ontario
A. P. Pinsak and G. K. Rodgers

The Water Movement Program
J. H. Saylor et al.

The Lake Meteorology Program

(a) Atmospheric Water Balance Project
E. M. Rasmusson and H. L. Ferguson

(b) Precipitation (Radar) Project
J. Wilson and D. M. Pollock

(c) Basin-Wide Meteorological Analyses
D. W. Phillips and J. A. Almazan

The Atmospheric Boundary Layer Program
J. Z. Holland and F. C. Elder

The Biology and Chemistry Programs

(a) Status of the Biota of Lake Ontario
N. Thomas and W. J. Christie

(b) Materials Balance of Lake Ontario
D. J. Casey, A. Fraser and K. Crawford

(c) Results of IFYGL Chemical and Biological Research
W. J. Christie and N. Thomas

Evaporation Synthesis Program
F. H. Quinn and G. den Hartog

IFYGL Summary Volume
T. L. Richards and E. J. Aubert

It is now the intent of the Joint Management Team to publish the entire series in one, or possibly two, hard-bound volumes under the title "IFYGL - A Scientific Summary of the International Field Year for the Great Lakes." Each section will undergo scientific and editorial reviews, with final editorial responsibilities belonging to the Scientific Editors.

Section (b) of the Lake Meteorology Program, "Precipitation (Radar) Project" was the first to undergo complete review and editing. As it will be some time before the final publication goes to press, this report was published as IFYGL Bulletin No. 20, special issue, in July 1977.

SPECIAL IFYGL SESSION AT THE INTERNATIONAL LIMNOLOGY SOCIETY CONFERENCE

Nine IFYGL papers were presented at the International Limnology Society meeting held in Copenhagen, Denmark, during the week of August 8, 1977. A. Robertson of the Great Lakes Environmental Research Laboratory chaired the session.

IFYGL BIBLIOGRAPHY

A joint Canadian-United States list of publications related to IFYGL has been included in each issue since IFYGL Bulletin No. 13. This issue contains as complete a listing of publications as we have been able to obtain from the IFYGL participants. Copies of many of these reports are available upon request from the IFYGL Coordinators:

Canadian IFYGL Coordinator
Atmospheric Environment Service
Department of Fisheries & Environment
4905 Dufferin Street
Downsview, Ontario M3H 5T4

U.S. IFYGL Coordinator
Great Lakes Environmental Research Laboratory
2300 Washtenaw Avenue
Ann Arbor, Michigan 48104

Official IFYGL Publications

IFYGL Bulletin Nos. 1-19 (January 1972 to June 1977)[1,2]

IFYGL Technical Plan, Volumes 1-4 (series complete, 1971)[1]

IFYGL Canadian Projects, March 1972 (series complete, 1973)

Canadian Projects	Supplement	No. 1 - July	1972
"	"	"	No. 2 - October	1972
"	"	"	No. 3 - February	1973
"	"	"	No. 4 - June	1973

IFYGL Technical Manual series

No. 1 "Methods of Measuring Soil Moisture" by R. G. Wilson, 1972[2].
No. 2 "Radiation Measurement" by J. Ronald Latimer, 1972[1,2].
No. 3 "Measurement of Currents in the Great Lakes" by M. D. Palmer 1973.[2]
No. 4 "U.S. IFYGL Precipitation Data Acquisition System" by A. L. Hansen, J. W. Wilson, C. F. Jenkins, and L. A. Weaver, 1973[1,2].
No. 5 "U.S. IFYGL Shipboard Data Acquisition System" by A. Robertson, 1974[1,2].
No. 6 "IFYGL Rawinsonde Data Acquisition System" by C. J. Callahan, J. A. W. McCulloch, E. J. Aubert, and E. M. Rasmussen, 1976[1,2].
No. 7 "Operational Characteristics of the DECCA Lambda (6f) Positioning System Over Fresh Water" by F. L. DeGrasse and F. Brunavs, 1975[1,2].

Final Canadian Data and Information Catalogue[1,2], ed. J. W. Byron, April 1976

Two Nations, One Lake - Science in Support of Great Lakes Management[1,2]

Objectives and Activities of the International Field Year for the Great Lakes 1965-1973. Prepared by John O. Ludwigson for the Canadian and U.S. National Committees for the International Hydrological Decade, May 1974, 145 pp.

Proceedings, IFYGL Symposium, Fifty-Fifth Annual Meeting of the American Geophysical Union, Washington, D.C., April 8-12, 1974, August 1974, 169 pp.[1,2]

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[1] Available in the U.S. from the
U.S. IFYGL Project Office
Great Lakes Environmental
Research Laboratory
2300 Washtenaw Avenue
Ann Arbor, Michigan 48104

[2] Available in Canada from the
Canadian IFYGL Centre - ACHC
Atmospheric Environment Servic[e]
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<u>UNITED STATES</u>

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A NOTE FROM THE U.S. COORDINATOR

Among the items contained in the front section of this issue of the IFYGL Bulletin was the notice that this is the last issue to be published in a status report format. There will be a special edition of the Bulletin containing the results of the IFYGL Wrap-Up Workshop.

This issue contains three articles on the results of U.S. IFYGL task work as well as the final task status reports. All but a very few tasks have been completed or are in the final report stage.

The original purpose of the IFYGL Bulletin was to provide a complete and continuing documentation of the progress of the IFYGL program, a means of communication between the IFYGL participants, and a vehicle for distributing information on the IFYGL program to all interested parties. I believe that the Bulletin has served its purpose well, thanks to the many contributors and, most of all, the Panel Cochairmen, Task Scientists, and Data Managers. The completeness of the documentation reflects the cooperation and efforts on the part of all these participants. May Laughrun deserves a special bouquet for handling the editing and publication details so very well. I thank one and all for their help.

A MODEL OF LAKE ONTARIO'S CIRCULATION

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Introduction

The purpose of this project was to use the Lake Ontario observations made during the International Field Year for the Great Lakes in 1972 to develop a numerical model of the lake's circulation to aid in understanding this circulation, and to provide estimates of currents and temperature for models of the lake's chemistry and biology. These goals required analysis of current, temperature, and wind data, and the detailed study of several simple models. This report summarizes the published work from the project, and gives a brief statement of major research results.

Publications

Specifically, this project called for a detailed analysis of the lake's circulation in mid-summer and its transient response to wind. This was accomplished by the following publications:

Bennett, J. R., 1975: "The Circulation of Large Lakes." Proceedings of the Third International Symposium on Upwelling Ecosystems, Kiel.

Bennett, J. R., 1975: "Nonlinearity of Wind-Driven Currents." Proceedings of the Symposium on Modeling of Transport Mechanisms in Oceans and Lakes, Canada Centre for Inland Waters, Manuscript Report Series, No. 43, Marine Sciences Directorate, Department of Fisheries and the Environment, Ottawa.

Bennett, J. R., and E. J. Lindstrom, 1977: "A Simple Model of Lake Ontario's Coastal Boundary Layer." To appear in Journal of Physical Oceanography.

Bennett, J. R., 1977: "A Three-Dimensional Model of Lake Ontario's Summer Circulation. I. Comparison With Observations." To appear in Journal of Physical Oceanography.

Bennett, J. R., 1977: "A Three-Dimensional Model of Lake Ontario's Summer Circulation. II. A Diagnostic Study." To be submitted to Journal of Physical Oceanography.

Bennett, J. R., and E. J. Lindstrom, 1977: "A Long-Term Simulation of Lake Ontario's Circulation." In preparation.

"The Circulation of Large Lakes" is a review of the last two decades of research on the circulation of the Great Lakes. It also contains a comparison of an early version of the model with observations of Lake Ontario, and some calculation of steady-state flow in a circular lake model.

"Nonlinearity of Wind-Driven Currents" compares two explanations of the tendency for currents in downwelling regions to be stronger than in upwelling regions. This study was motivated by the Lake Ontario observations which, in summer, seemed to show a much larger response at the shore to the right of the wind. One explanation is based on inertial accelerations; the other, on large displacements of the thermocline. The major finding is that both could be important in some lakes, but that, for Lake Ontario, it is not necessary to include the inertial accelerations.

In "A Simple Model of Lake Ontario's Coastal Boundary Layer" the coastal transect data taken during the IFYGL are used for developing an empirical description of the lake's response to wind. The model consists of three linear wave equations for computing the depth of the thermocline, its slope, and the longshore volume transport as functions of position along the shore and time. The empirical phase speeds agree with theoretical values of internal Kelvin waves and topographic waves. The empirical decay times of the model are long, from 5 to 20 days; this suggests that the earlier version of the model could be improved by lowering friction.

The two-part paper, "A Three-Dimensional Model of Lake Ontario's Summer Circulation," describes the final version of the numerical model and gives a detailed analysis of the physical processes that drive the current. Part I is a comparison with observations. Part II is an analysis of a two-layer circular lake model, where the calculations were designed so that the physical processes could be isolated and the numerical method could be analyzed. It shows that the model reproduces both the mean circulation and the current reversals due to low frequency waves.

Finally, in "A Long-Term Simulation of Lake Ontario's Circulation," the model is applied to a 30-week period of the Field Year (April 22 to November 17, 1972). The computed surface temperatures are compared with Irbe's airborne radiation thermometer measurements, and the computed currents are illustrated by computing the results of imaginary dye experiments.

Major Results

The most interesting part of this research is the analysis of a large wave during July and August 1972. The wave defies any simple description, but it has characteristics of both an internal Kelvin wave and a topographic wave. The strongest currents are parallel to shore and confined to within about 10 km of the coast. The longshore wavelength is essentially the entire perimeter of the lake, though undoubtedly shorter scales were present that were not resolved by the observations. It was the failure of the early version of the model to reproduce this wave correctly that led to the improved model.


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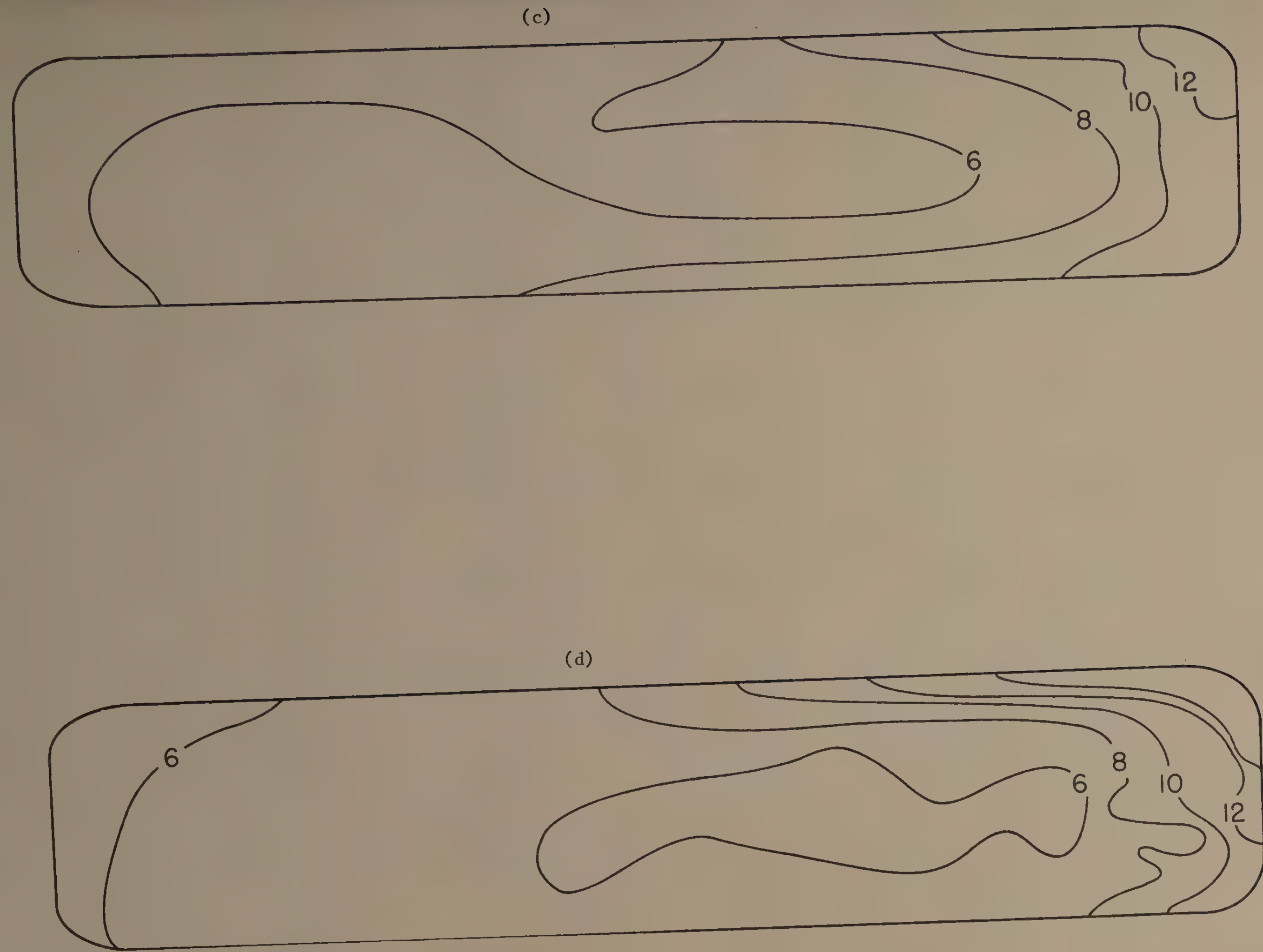

Figure 1.--(a) Observed average temperature (°C) of Lake Ontario from 20 m to 40 m, August 1-3, 1972; (b) temperature computed with the 5-km uniform grid model; (c) and (d) temperature computed with the stretched grid model with high and low friction, respectively.

Figure 1 summarizes the highlights of this improvement. At the top (fig. 1a) are data from the ship cruises from August 1 to 3, showing the average temperature at 20- to 40-m depths, below the average position on the thermocline. There is a thin band of warm water along the north shore due to downwelling of the thermocline. The coastal chain data show that this was due to a strong pulse of wind from the west about a week earlier. The direct effect of the wind was a downwelling along the south shore, but afterwards it propagated around the east end of the lake as an internal Kelvin wave would. Figure 1b shows the temperature prediction of the earlier 5-km uniform grid model. The model underestimates the propagation speed of the wave and the magnitude of the temperature gradient. Figures 1c and 1d show two cases of the improved stretched grid model. In the first case (1c), the value of friction is comparable to that used in (1b); in the second case (1d), it is much lower. With lower friction the thermocline depression travels farther towards the west and the temperature gradient is stronger. Other model experiments confirmed that both flow friction and increased resolution of the shore zone are essential; simply lowering friction in the uniform grid model does not improve the simulation.

The currents during this episode are large enough to move the water initially near the southeast shore around the east end to the northwest shore. This can be seen in figure 2, the computed result of an imaginary dye experiment. There are three dye experiments in the figure but the most interesting is the second, after the first restart. In this computation 10^{13} g of dye are released at the beginning of the 10th week at the southeast shore near Oswego. Three weeks later, at the end of the 12th week, the maximum concentration is 100 parts per million (ppm) near the eastern shore and only about 20 percent of the surface water of the lake has a concentration above 10 ppm. By the end of the 15th week (August 5) the model predicts the dye would have been confined to a thin band of water along the north shore where the maximum concentration would be 40 ppm.

Conclusions

I believe this project has contributed considerably to an understanding of Lake Ontario's circulation, particularly with regard to the complex currents of the coastal boundary layer.

Four types of models were used here: the three-dimensional model, the cross-section model, the two-layer circular model, and the empirical model. Comparing the models with observations and with each other revealed a type of order in the observations. The cross-section model put limits on the amount of nonlinearity one could expect. The empirical model told how much of the observed complexity was due to linear wave motion. The circular model was used to show that the small nonlinear rectification of these waves combined with the closed geometry could give realistic mean circulation patterns. Finally, the three-dimensional model was used to do somewhat more realistic calculations for direct comparison with observations. Thus, the final product here is more than simply the three-dimensional model - it is the three-dimensional model plus a variety of simple models isolating different aspects of the flow.

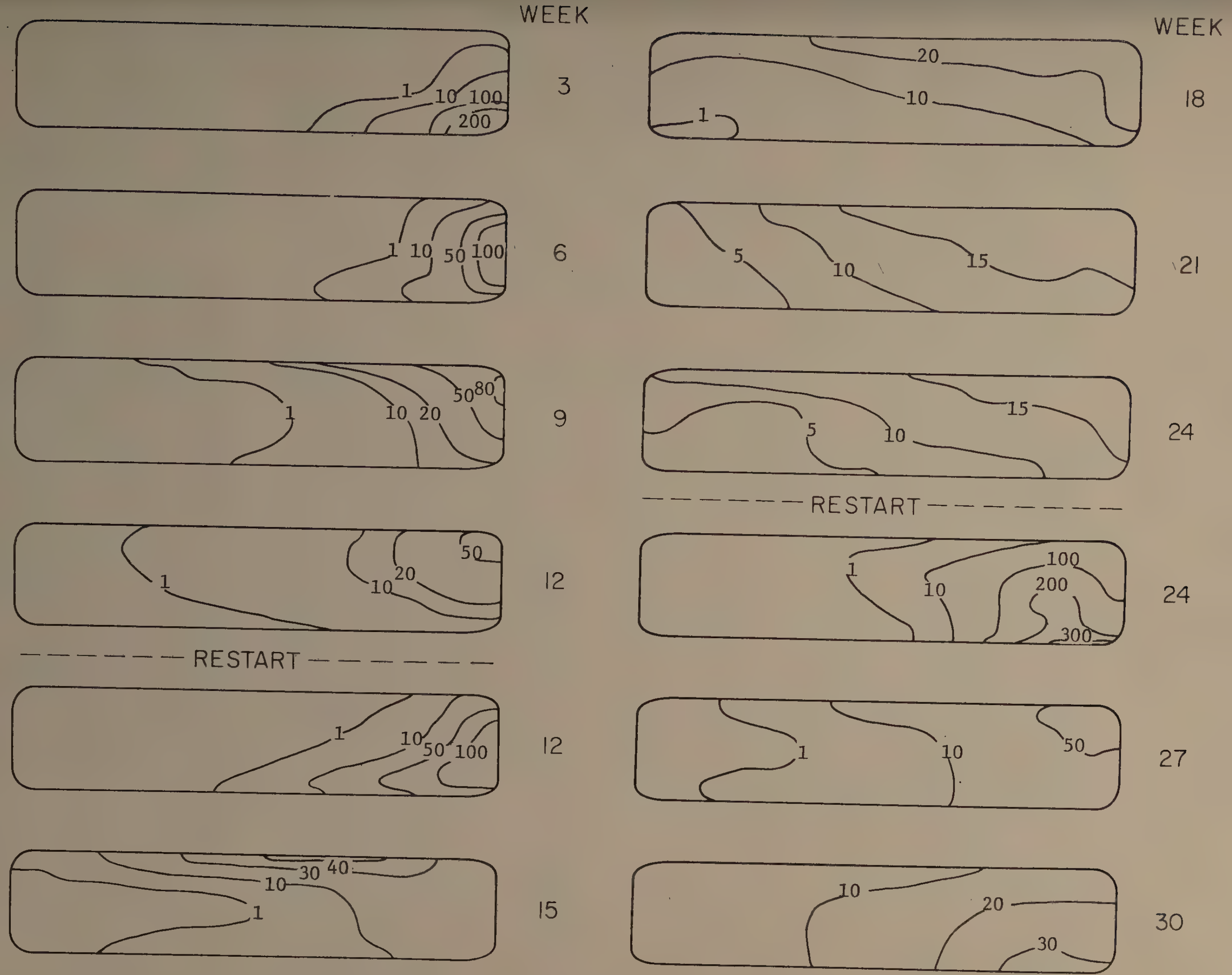

Figure 2.--Surface concentration (parts per million) for three advection experiments with sources at the south shore of Lake Ontario near Oswego, New York.

A SUMMARY OF IFYGL SURFACE WAVE STUDIES

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The immediate objective of the IFYGL surface wave studies was to describe the wind-wave climate of Lake Ontario during ice-free conditions. Such a description is required for the design of harbors and structures placed in or on the lake for increasing the safety of navigation and recreational activities, and for the mitigation of shore erosion. Long-term objectives include the improvement of forecasts of wind-wave generation for the Great Lakes; the determination of characteristics of wave growth at limited fetch and of wave decay in a large lake; and the improvement of design wave stastistics.

The instrumentation for the surface wave measurements consisted mainly of freely moored "Waverider" buoys. The Waverider buoy, manufactured by Datawell in Holland, is spherical in shape, 1 m in diameter, and weighs about 100 kg. It contains two main components: an accelerometer and a transmitter. The accelerometer, mounted on a pendulous system, measures the vertical component of acceleration as the buoy moves with the waves. Two electronic integrators in cascade then transform the output into a voltage that represents the vertical displacement of the buoy. This voltage controls the frequency of an audio oscillator, which modulates a crystal-controlled transmitter that transmits the signal by telemetry to a shore receiver. Seven Waverider buoys were used during IFYGL. The precise locations of the buoys, their nearest IFYGL Physical Data Collection System (PDCS) buoy station, their periods of operation, and their water depth are given in table 1.

The first three Waverider buoys listed in table 1 were operated by the Marine Science Branch of the Canada Department of the Environment. The data were recorded for 20 min every 3 hr. The processed data were stored on magnetic tapes and in the form of manual records (Byron, 1976). The last four Waveriders were operated by NOAA's Lake Survey Center. The data were recorded continuously on analog magnetic tapes, and after processing were stored on digital magnetic tapes. A general discussion of the data analysis has been published and a data report issued (Liu and Robbins, 1974; Liu and Kessenich, 1975).

Waves in Lake Ontario were also observed visually from commercial and research vessels during IFYGL. These data are archived on cards at the National Climatic Center in Asheville, North Carolina. Each card bears the ship's position and a complete set of observations of weather conditions, including many visual estimates of wave height and period at the time of observation. Observations were made regularly at 3-hr intervals, starting at 0000 GMT, and additional observations were made at other times if warranted by meteorological conditions. These visual observations have been compared by Liu and Kessenich (1976) with wave measurements.

Table 1.--Waverider buoy locations

Location	Lat. N	Long. W	Nearest PDCS buoy no.	Period of operation	Water depth (m)
Cobourg	43°49'30"	78°02'30"	8	Apr. 12-Dec. 4	70
Main Duck Island	43°51'40"	76°39'30"	11	Apr. 19-Nov. 21	40
Toronto	43°31'00"	79°19'00"	2	Mar. 11-Apr. 15	120
Brockport	43°35'18"	78°00'48"	14	May 12-Nov. 23	180
Oswego-1	43°31'48"	76°37'12"	20	May 11-Nov. 16	156
Oswego-2	43°39'25"	76°44'15"	19	June 19-Nov. 13	139
Puttney-ville	43°35'41"	77°23'42"	17	July 5-Nov. 22	148

The voluminous wave data collected during IFYGL provided an abundant data source for surface wave studies. Main emphasis in the studies reported on to date has been on wave statistics, wave processes, and wave hindcasting.

An overview of the wave statistics is given in figures 3, 4, and 5. The long-term distribution of significant wave height is shown in figure 3, and of the wave period in figure 4. The well-defined linear relationships (resulting from plotting on probability paper the percentage of time a given wave height or period is exceeded vs. the logarithm of wave height or period) indicate that the distributions can be represented log-normally as has been noted in many oceanic studies. As seen, wave heights of 2 m or more and wave periods of 4 s or more occur less than 5 percent of the time. Figure 5 is a scatter diagram showing the correlation of wave height with corresponding wave period. The numbers of occurrences are expressed in tenths of one percent. Contours of equal frequency of occurrence were drawn to bring out the distributions more clearly. Based on the relationship derived from linear wave theory between wave period, T, and wave length, L, i.e., $L = gT^2/2\pi$, the wave steepness, defined as the ratio of wave height to wave length, can be obtained. Lines of constant wave steepness are also included in figure 5. Based on combined data recorded from all four U.S. Waveriders, this figure shows that the majority of recorded waves cluster around steepness lines of 1:10 and 1:20. The most frequent conditions are those with a significant height of 0.5 m and a wave period of 2.5 s. The wave statistics studied do not show significant seasonal variations other than that waves were higher in autumn than

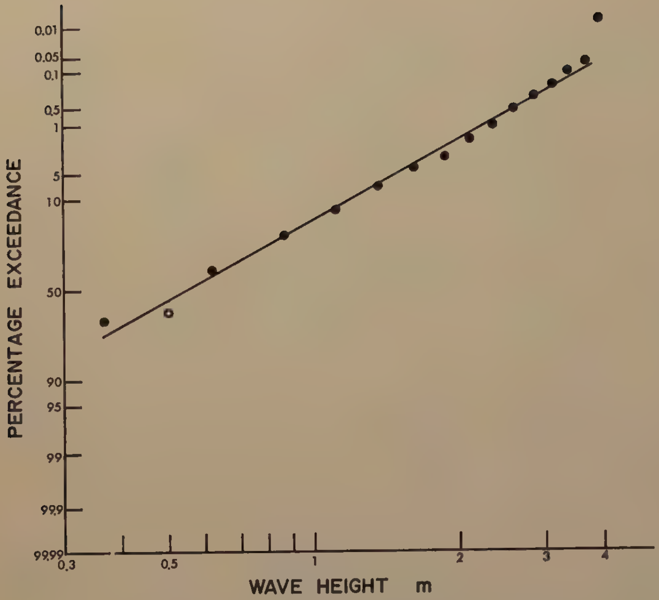

Figure 3.--Wave height distribution.

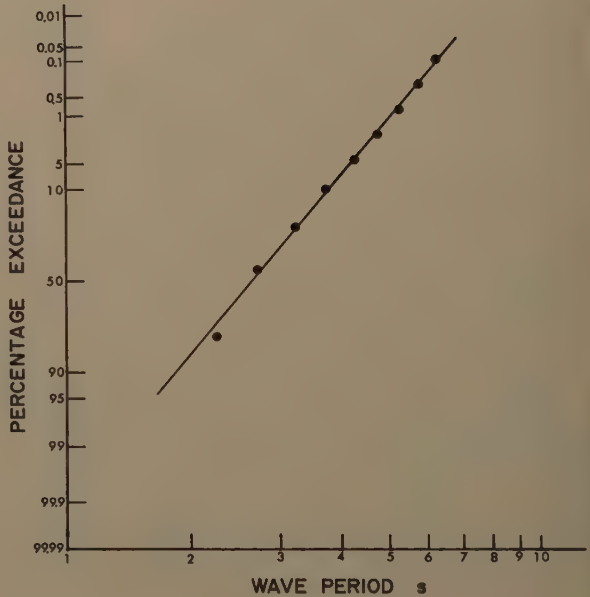

Figure 4.--Wave period distribution.

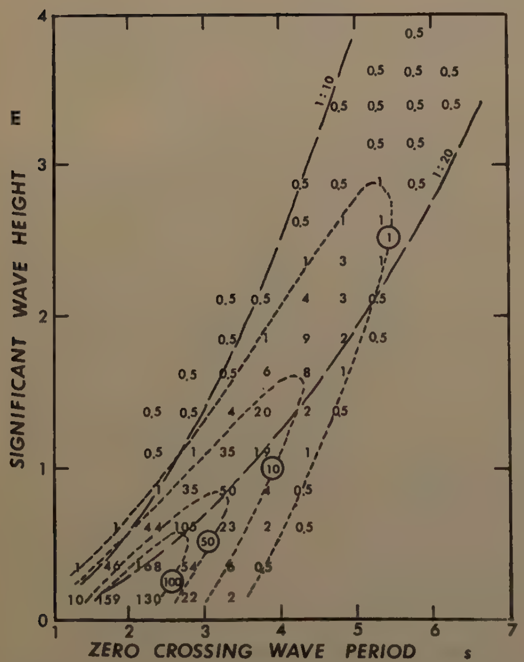

Figure 5.--Relation of wave height to corresponding wave period.

in summer, reflecting the fact that during the autumn the atmospheric boundary layer becomes unstable, the momentum flux across the air-water interface is enhanced, and storms are more frequent.

Studies of wave processes have been concentrated on empirical examination of the growth and decay behavior of wave spectra. Analysis of the hourly wave spectra during Hurricane Agnes, June 22-23, 1972, from the Oswego-1 and Oswego-2 Waveriders showed that the growth and decay of significant wave heights follow increasing and decreasing wind speed in an approximately linear time pattern (Liu, 1974). The initial growth of wave spectra from a relatively calm condition is quite rapid and the growth rate is not linear. The temporal growth and decay of individual spectral components varies among the frequencies, but they can be generally grouped into three spectral ranges: a low frequency range, where the components are most sensitive to wind; a high frequency range, where the components are mostly independent of time or wind stress; and a middle frequency range, which possesses both high and low frequency range properties. These studies are continuing, with the scope expanded to include examination of nonlinear wave-wave interactions.

Two studies on wave hindcasting have been reported (Rasio and Vincent, 1976; Liu, 1976), in which some of the IFYGL wave data were used for model calibration and comparison. As new wave forecasting models are developed, the IFYGL wave data can be expected to play an important role in verifying and improving these models.

In summary, suffice it to say that the seven Waverider buoys provided significant lake-wide wave measurements, and that the data collected represent an important and unique base for continuing studies of wind-generated waves. Only a small number of studies have been reported so far, but these data will undoubtedly be used for many years to come.

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Rasio, D. T., and C. L. Vincent, "Design Wave Information for the Great Lakes: Lake Ontario," Technical Report H-76-1 (Report 1), Hydraulics Laboratory. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, 1976, 148 pp.

EVALUATION OF U.S. IFYGL CHEMICAL DATA AT THE MASTER STATIONS

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Introduction

The chemical data collected by the Researcher and Advance II in Lake Ontario during the field phase of the International Field Year for the Great Lakes (IFYGL) is a potentially valuable data set, unique in its sampling frequency in time and space. A total of 31 cruises were scheduled at approximately 1-week intervals from May 3, 1972, through December 2, 1972, and subsequent data for winter and spring 1973 were collected by U.S. personnel on Canadian vessels. Six Researcher cruises concentrated on chemical and biological data and sampled up to 60 of the 105 IFYGL stations; other cruises gathered extensive chemical data primarily at the master stations, 10, 24, 45, 75, and 97 (fig. 6). A comprehensive description of the ship system has been given by Robertson (1974).

Although all five of the master stations were not visited on every cruise, sufficient data were gathered to permit a rather complete description of the annual cycle of offshore chemical characteristics. Robertson et al. (1974), however, present a statistical analysis of IFYGL chemical data collected for intercomparison purposes, which shows considerable variation among laboratories and some poor results for analyses of samples of known composition. Our work with the cruise data revealed inconsistencies that suggested a need for evaluating the quality of the data. This report deals with the results of such an evaluation pertaining to the chemical data as they now reside in archive form on the EPA STORET system.

Methods

The 12 parameters chosen for analysis and their STORET codes are:

(1) pH (400).
(2) Total alkalinity (410).
(3) Dissolved ammonia (608).
(4) Total Kjeldahl nitrogen (625).
(5) Dissolved nitrite/nitrate (631).
(6) Total phosphorus (665).
(7) Dissolved phosphorus (666).
(8) Dissolved orthophosphate (671).
(9) Total organic carbon (680).
(10) Dissolved calcium (915).
(11) Dissolved sulphate (946).
(12) Dissolved silicate (955).

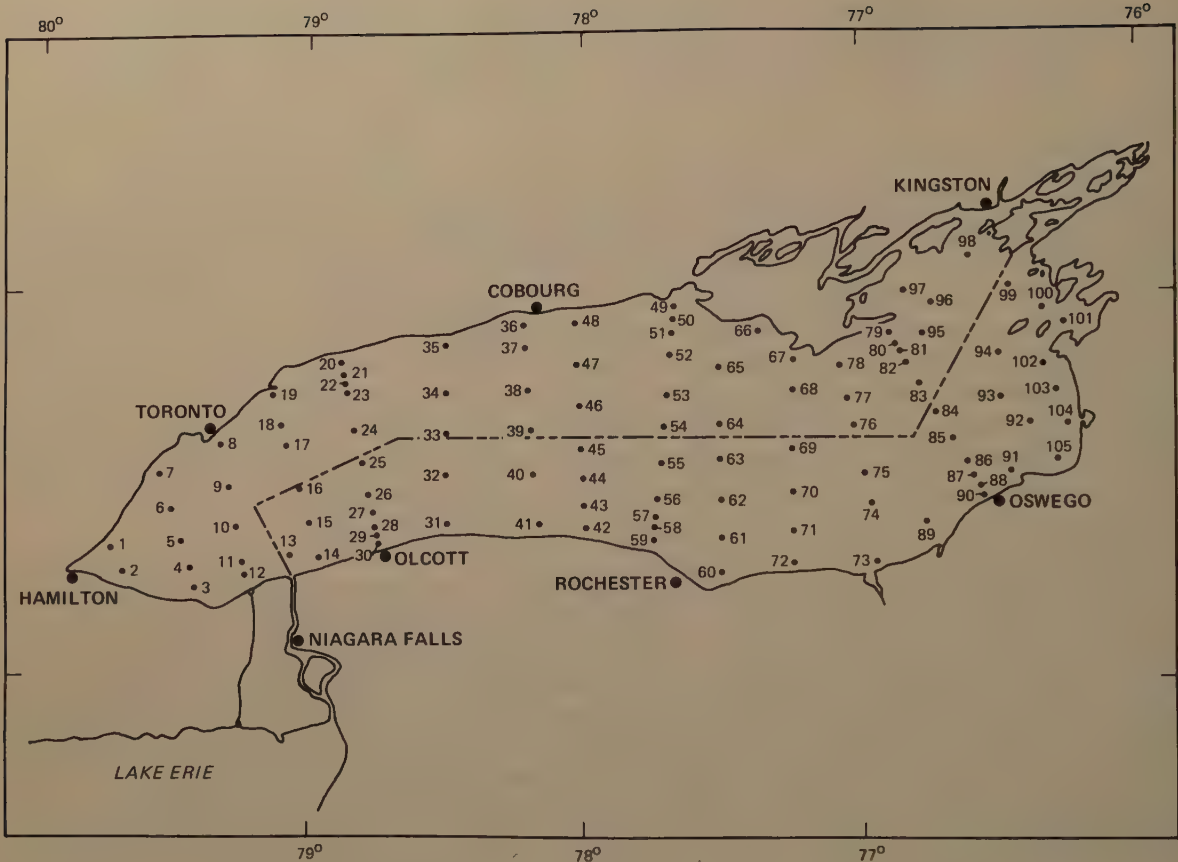

Figure 6.--Location of U.S. IFYGL ship stations.

In the analysis that follows, Julian days are used, January 1, 1972, being Julian day 1 and January 1, 1973, Julian day 367. To obtain sufficient sample sizes for the analysis, we assumed that the hypolimnion would be relatively homogeneous for midlake stations over a 4-day period (approximately 1 cruise), and for each cruise we aggregated all data at or below 45 m for master stations 10, 24, 45, and 75. Station 96 was too shallow (35 m) to be used, and the other stations were not sampled frequently enough to warrant their inclusion. This resulted in a maximum sample size of 14 data points per cruise; the data were not further aggregated across time because of expected temporal variations in some of the parameters. The data were compared with independent historical data and were evaluated statistically. Most of the comparative data used were means of IFYGL data taken by Canada Centre for

Inland Waters (CCIW) during the same time period, or, when necessary, CCIW data collected during 1967 and 1969. Other data sources are mentioned where appropriate. When possible, 25 percent trimmed means (to examine the effect of editing of outliers) and 95 percent confidence intervals were calculated for each parameter for each cruise and compared with the independent data. To facilitate interparameter comparison, the variability of each parameter was examined based on the coefficient of variation, CV (CV = [100 x standard deviation/mean] %), rather than on the standard deviation.

Strictly speaking, the CV and confidence intervals should be used only if the data on each cruise were normally distributed. However, if the hypolimnion on a given date were indeed homogeneous and if the data values were subject only to random sampling and measurement errors, normality is to be expected. Four techniques were used to check for normality and randomness, and when the data appeared not to meet these assumptions the actual data points themselves were examined. The four techniques were the Lilliefors test, two nonparametric runs tests, and skewness and kurtosis tests. The α level was set at 0.05. We considered rejection by two or more of the tests to be a fairly strong indication of non-normality or nonrandomness.

Plots of the means for each of the 12 data sets, 95 percent confidence intervals (assuming normality), ranges, and comparison data from other sources are shown in figures 7 to 18.

Results

pH (fig. 7). From figure 7 it appears the means of the U.S. and Canadian IFYGL data are in fairly good agreement. However, the variability in the U.S. data is large. The variability in pH due to natural pH variations, accuracy of the meter, or sampling variation combined should not be much more than 0.1 unit.

Statistically the data are also suspicious. Means vary erratically over time, and the data in terms of (H^+) are often not normally distributed. Two-thirds of the cruises give evidence of positive skewness, indicating that outliers tend to be low pH, i.e., high (H^+), values.

Total alkalinity (fig. 8). On the whole the total alkalinity data are questionable. The six data sets between Julian days 131 to 166 have reasonable means, a small variability (CV ≃ 5 percent), and compare favorably with the Canadian IFYGL data shown in figure 8. The remaining nine data sets have means surprisingly high or low compared with the Canadian data, even though the variability as expressed by the CV is usually about 5 percent. Four data sets are particularly bad: on Julian days 124 and 216 the CV's are 5 to 10 times as large as on other dates, and the means are low. On days 403 and 528 the values are unquestionably wrong, with means of 8.67 and 8.63. The statistical evaluation is inconclusive but suggests non-normality and nonrandomness.

Dissolved ammonia (fig. 9). Figure 9 shows moderate agreement between the U.S. IFYGL data and Canadian data taken in 1969. The Canadian data fall

within the 95 percent confidence intervals of the American data about half the time, and, since these values are all near the limits of detection, the agreement between the two data sets is probably reasonable. (The Canadian value of 0.05 mg/l plotted for day 114 and day 479 is suspect.)

Statistically the U.S. data are marginally satisfactory. Considerable variability is in evidence, with an average CV of about 70 percent. Most of the data through Julian day 258 do not appear to be normally distributed and seem to tend towards being positively skewed. Examination of the data, however, indicated this to be due to a large number of 0.005 values, which apparently was the limit of detection of the tests run for those times.

We believe averages of the data over a number of stations probably give an idea of ammonia concentrations, although precision is low because values are near the limits of detection.

Total Kjeldahl nitrogen (fig. 10). The U.S. IFYGL total Kjeldahl nitrogen data exhibit a CV that is relatively high, ranging from 15 to 75 percent and average about 40 percent. Virtually all confidence intervals overlap, indicating no statistically discernible seasonal trend. In about half the cases the assumptions of randomness or normality were rejected, but only in three instances by more than one test. Twenty-five percent trimmed means were noticeably different from untrimmed means in about one quarter of the data sets.

The U.S. total Kjeldahl nitrogen data seem to be internally consistent and statistically satisfactory, but have considerable variability and are substantially lower than Canadian data taken in 1967 and 1972-73.

Dissolved nitrite/nitrate (fig. 11). The U.S. dissolved nitrite/nitrate data appear of questionable quality as the assumptions of randomness and normality do not hold for many dates. Examination of the data showed two major problems. One is the fairly common occurrence of very large values. The second is the frequent finding that mean values at the various stations differ. The latter suggests the hypolimnion is simply not suitably homogeneous, but the former casts doubts on the validity of the data values themselves.

The 25 percent trimmed means are in general lower than the untrimmed values, and when plotted, as shown in figure 11, they indicate quite good agreement between the U.S. and Canadian data. Hence, we suggest that the STORET IFYGL nitrite/nitrate data are reasonable but should be edited for outlying values.

Total phosphorus (fig. 12). Means of the U.S. data vary considerably over time but the data are satisfactory from a statistical standpoint, with an average CV of about 35 percent. Twenty-five percent trimmed means tend to be a bit lower than the untrimmed means, but not substantially so, and they vary just as erratically over time. The assumptions of randomness and normality were rejected in 11 instances, but only in 4 of these by more than one test. These 4 had one or two stations with values considerably larger than the other stations. We feel the STORET total P data is reasonable but may benefit from editing, particularly for high values.

Dissolved phosphorus (fig. 13). Figure 13 shows rather poor agreement between U.S. and Canadian IFYGL dissolved phosphorus data. In only three instances do the 95 percent confidence intervals about the U.S. means include the Canadian values, and, overall, the U.S. values average about 60 percent of the Canadian. The CV's are moderately high, and range from about 9 to about 80 percent, with an average somewhat over 30 percent.

The hypotheses of normality and randomness were rejected for half (12) of the data sets, and in 6 of these the rejection was by more than one test, a fairly strong indication of nonrandomness or non-normality. Examination of the data values indicated frequent occurrence of relatively high outliers; this is also suggested by the fairly common finding of positive skewness. In addition, the 25 percent trimmed means tend to be lower than the untrimmed values, but the average change is only about -4 percent.

We conclude that the U.S. IFYGL dissolved phosphorus data are suspect; however, when outliers are removed, the data seem statistically satisfactory.

Dissolved orthophosphate (fig. 14). The STORET IFYGL data are not in agreement with the 1969 Canadian data, which average about 2.5 times higher, although a reasonable seasonal trend of a minimum in June, July, and August and an increase throughout the fall is reproduced in both data sets. The means throughout the time period examined vary erratically and have fairly large CV's, ranging from about 25 to 140 percent. Twenty-five percent trimmed means in general are lower than untrimmed means. The assumptions of randomness and normality were rejected by the statistical tests for about half the data sets examined, although only through Julian day 166 was this generally by more than one of the tests. Examination of the data indicated the cause during this time period was primarily the occurrence of many values of 0.001, apparently the limit of detection of the test. Later in the year, measured orthophosphate values were higher and hence could be recorded more accurately. Given the large intercruise and intracruise variability in the data and the poor agreement with 1969 Canadian values, we believe that the dissolved orthophosphate data are probably not usable.

Total organic carbon (fig. 15). No historical data were found with which to compare the U.S. IFYGL data set except one value from the Great Lakes Basin Framework Study (Great Lakes Basin Commission, 1976), where the average total organic carbon in Lake Ontario above 25 m is given as about 7.5 mg/l. This is approximately twice as high as values seen in figure 15.

Statistically, the data appear satisfactory. The CV is moderately high at about 30 percent. The means vary somewhat erratically across time, but the seasonal pattern discernible by eye, though not verifiable statistically, is reasonable: general decrease through May, then an increase through fall, and a decrease again through the first part of 1973. Tests for randomness and normality are inconclusive, although examination of the data points indicated considerable intracruise variability. With a few exceptions 25 percent trimmed means are only slightly smaller than the untrimmed. Having no reason to conclude otherwise, we believe the total organic carbon data are good.

Dissolved calcium (fig. 16). No conclusive evidence of a seasonal pattern is seen in the U.S. IFYGL calcium data. The overall mean is 38.2 mg/l, which is somewhat lower than the sketchy historical data available for comparison. A Canadian cruise in October 1967 found an average hypolimnetic calcium concentration of 41.2. Weiler and Chawla (1969) reported a whole lake (epilimnion and hypolimnion) average in October-November 1968 of 40.3, while Kramer (1964) reported a value of 39.

Statistically, the data appear satisfactory. In most cases the variability is low, with an average CV of about 5 percent. In four instances the hypotheses of randomness or normality were rejected, but only on Julian day 145 was the rejection by more than one test. Examination of the data for that date showed a number of extremely low values (in the 20's) recorded for IFYGL station 75, which also explains the rather high CV. Similarly, the high CV on day 138 appears to be the result of relatively high values at station 24.

We conclude that the calcium data are good if edited for particularly high or low values.

Dissolved sulphate (fig. 17). Much of the U.S. IFYGL sulphate data is suspect, although only a limited amount of independent data was found for comparison. Two October 1967 Canadian cruises found a hypolimnetic average of 27.1 mg/l. Weiler and Chawla (1969) reported a whole-lake average of 29.4 during October-November 1968. Two February 1972 Canadian IFYGL cruises averaged 29.2 below 45 m. These suggest a fairly constant sulphate concentration of about 27 to 30 mg/l. Many of the U.S. IFYGL data through Julian day 272 are considerably higher or lower than this, ranging from a high of about 65 to a low of 6 and having moderately high CV's of 20 to 60 percent. Subsequent U.S. values from day 286 on are much more in agreement with the comparison data, averaging 24 to 28, with a CV of 2 to 20 percent. The hypotheses of normality and randomness were rejected in somewhat over half of the data sets, although usually by only one test. Examination of the data in these cases indicated particularly high or low outliers among otherwise quite similar values. In addition, it was noted that through Julian day 180, values were usually given to the nearest 5 mg/l and after day 180 to the nearest 1 mg/l.

We believe that the U.S. IFYGL dissolved sulphate data through Julian day 272 (September 28, 1972) are in error, but are reasonable thereafter.

Dissolved silicate (fig. 18). There is a considerable amount of variability in the dissolved silicate data during each cruise,with an average CV of about 60 percent, but some cruises show considerably less variability than others. Although statistically not verifiable because of the large variability, there appears to be a reasonable seasonal pattern of low silica values through June or July and an increase thereafter. In 13 instances the assumptions of randomness or normality were rejected, although usually only by one of the statistical tests. Examination of the data for these cases suggested the cause was often differences between station means. In general the 25 percent trimmed means are in closer agreement with Canadian 1967 and 1969 data.

The silicate data appear reasonable, but exhibit considerable variability, and we recommend the data be edited for outliers.

Conclusions

The data sets analyzed here were hypolimnion chemical data gathered by U.S. personnel at four master stations during the field phase of IFYGL in 1972-73. They have been placed in the EPA STORET system in supposedly archive form, but we found a substantial amount of erroneous data. For some parameters only a few individual points were bad; for others, the total data set was suspect.

If the quality of each data set is rated A through D, with A meaning usable with minimal editing and D meaning definitely suspect, the conclusions we reach are given in table 2. Only total organic carbon possibly rates A, and that only on its statistical properties as no independent data were found for comparison. Dissolved sulphate also rates A after day 272 (September 28, 1972) but included are less than half the cruises, none of which are in the biologically active spring and summer.

Classified as B are dissolved ammonia, dissolved nitrite/nitrate, total phosphorus, dissolved calcium, and dissolved silicate. From a statistical standpoint the dissolved ammonia data set would not rate B because of its high variability and frequent non-normality, but the test is difficult to perform and the data set is unique. It compares moderately well with the 1969 data used for comparison.

The dissolved nitrite/nitrate data require extensive editing for high and low values, but they then agree quite well with independent comparison data. Total phosphorus is only a marginal B because of the frequent occurrence of very high values, the erratic variation of the mean from cruise to cruise, and the generally low values when compared with 1969 data. Only a small amount of independent data was found for comparison with the dissolved calcium, but this data set agrees reasonably well if obviously high and low values for a few dates are removed. Dissolved silicate data exhibit considerable variation both among and between cruises and are in general a bit high in comparison with independent data.

Data sets classified as C, meaning of marginal usefulness, include pH, total alkalinity, total Kjeldahl nitrogen, and dissolved phosphorus. These cannot be much improved by editing. The pH and total alkalinity data are with a few exceptions not widely in disagreement with the independent data used for comparison,but many points are far enough outside the expected range for these parameters to make the data only marginally useful. The total Kjeldahl nitrogen data set does not appear bad from a statistical standpoint, but the two independent data sets used for comparison are 1.5 to 2 times higher. Dissolved phosphorus data appear statistically satisfactory if outliers are removed, but are only about 60 percent as high as the independent data.

Table 2.--Classification of 12 U.S. IFYGL data sets.

Parameter	Class	Comments
pH	C	Excessive intracruise and intercruise variability. Moderate agreement with independent data.
Total alkalinity	C	Excessive intracruise and intercruise variability. Frequent poor agreement with independent data.
Dissolved ammonia	B	Considerable variability. Values often near limits of detection of tests.
Total Kjeldahl nitrogen	C	Internally consistent but low in comparison with independent data.
Dissolved nitrite/nitrate	B	Good agreement with independent data after editing.
Total phosphorus	B	Substantial intracruise and intercruise variability. Generally lower than comparison data.
Dissolved phosphorus	C	Internally consistent after editing but considerably lower than comparison data.
Dissolved orthophosphate	D	Considerable intracruise and intercruise variability. Much lower than comparison data.
Total organic carbon	A?	Internally consistent. No comparison data.
Dissolved calcium	B	Perhaps slightly low. Editing required.
Dissolved sulphate	D/A	Too high or low prior to Julian day 272 (September 28, 1972); high intracruise and intercruise variability. Good agreement with comparison data and low variability after day 272.
Dissolved silicate	B	Considerable intracruise and intercruise variability. Generally higher than comparison data.

A = usable with minimal editing.
B = usable with some editing but not of A quality.
C = marginally useful after editing.
D = suspect.

Comparison data: CCIW 1967, 1969, and 1972-73 cruises; Weiler and Chawla (1969); Kramer (1964); Great Lakes Basin Commission (1976).

Finally, the parameters that we classify as D, or definitely suspect, are dissolved orthophosphate and sulphate prior to Julian day 272 (October 28, 1972). The U.S. dissolved orthophosphate data exhibit considerable intracruise and intercruise variability, and the independent data used for comparison average 2.5 times higher. Dissolved sulphate could be compared with only a limited amount of independent data, but most values up to Julian day 272 disagreed so substantially with the data used for comparison that we think it unlikely that the data are valid. In addition, the high coefficients of variation for this data set compare unfavorably with the much lower CV's for the apparently good data after day 272.

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Robertson, A., F. C. Elder, and T. T. Davies, "IFYGL Chemical Intercomparisons (IFYGL)." Proceedings of the 17th Conference on Great Lakes Research, International Association on Great Lakes Research, 1974, pp. 682-696.

Weiler, R. R., and V. K. Chawla, "Dissolved Mineral Quality of Great Lakes Waters," Proceedings of the 12th Conference on Great Lakes Research, International Association on Great Lakes Research, 1969, pp. 801-818.

Key to figures 7 to 18:

In the plots of U.S. IFYGL data means, 95 percent confidence intervals, and ranges for the various parameters shown on the following pages, means are indicated by circles, 25 percent trimmed means by boxes; confidence intervals are enclosed by horizontal straight bars and ranges by curved bars; Canadian IFYGL data are indicated by hollow triangles, 1967 Canadian data by hollow squares, and 1969 Canadian data by hollow circles.

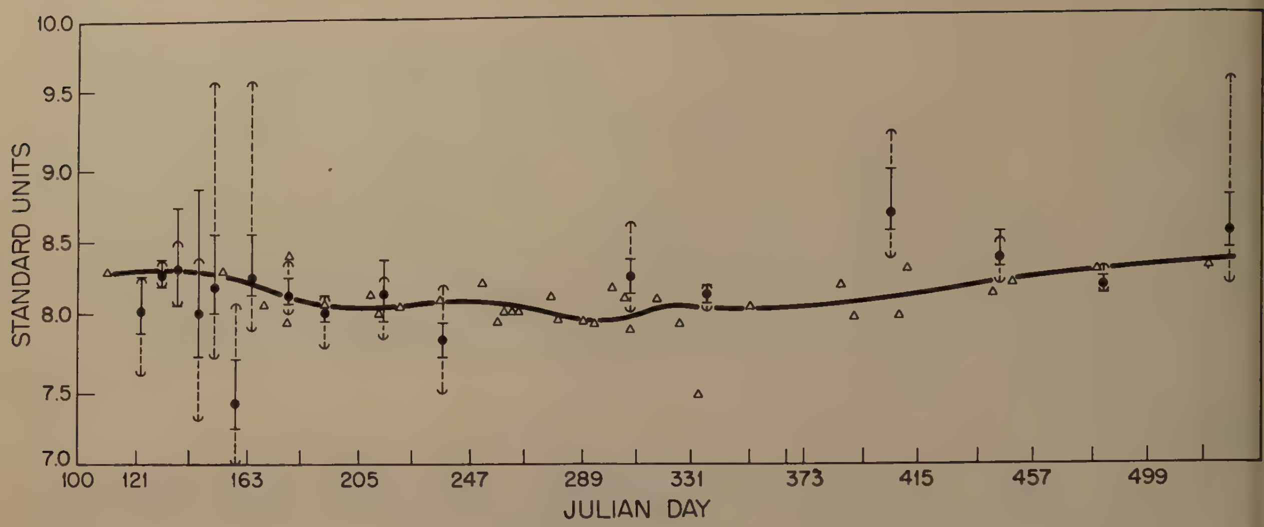

Figure 7.--pH.

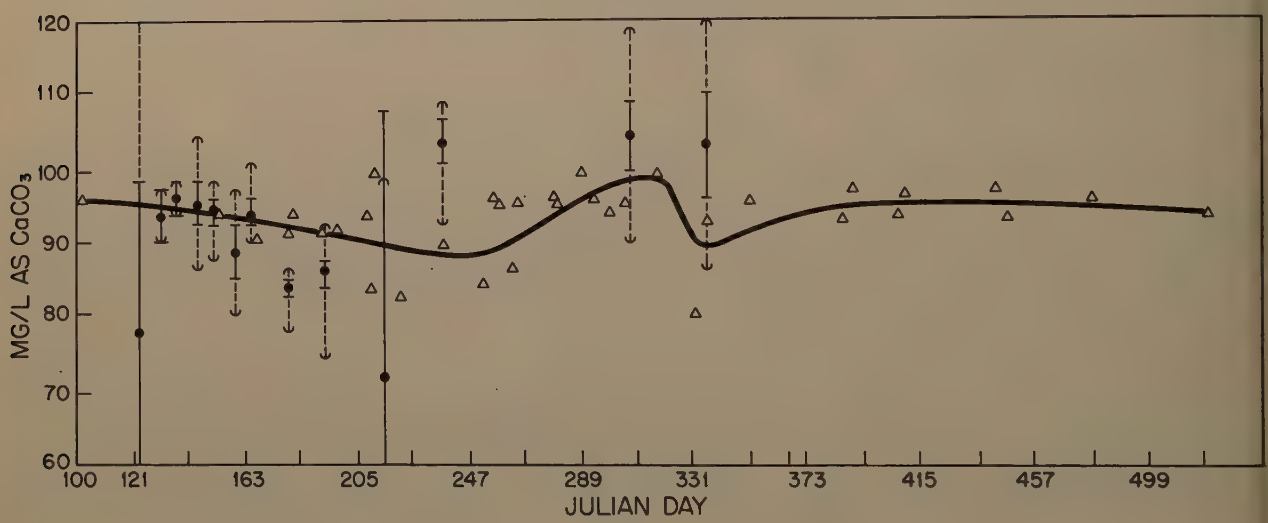

Figure 8.--Total alkalinity.

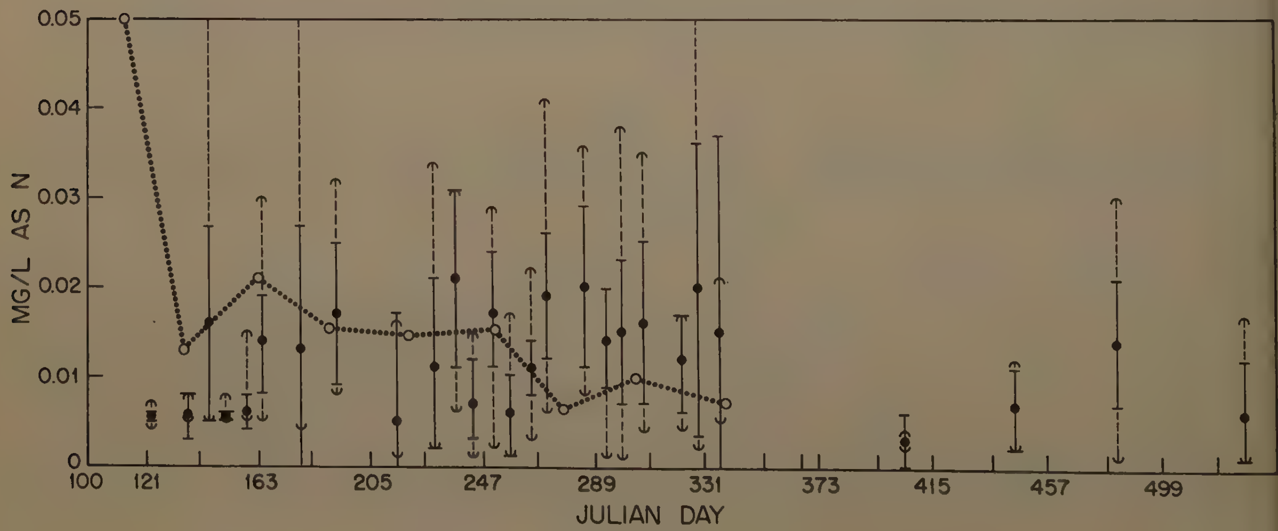

Figure 9.--Dissolved ammonia.

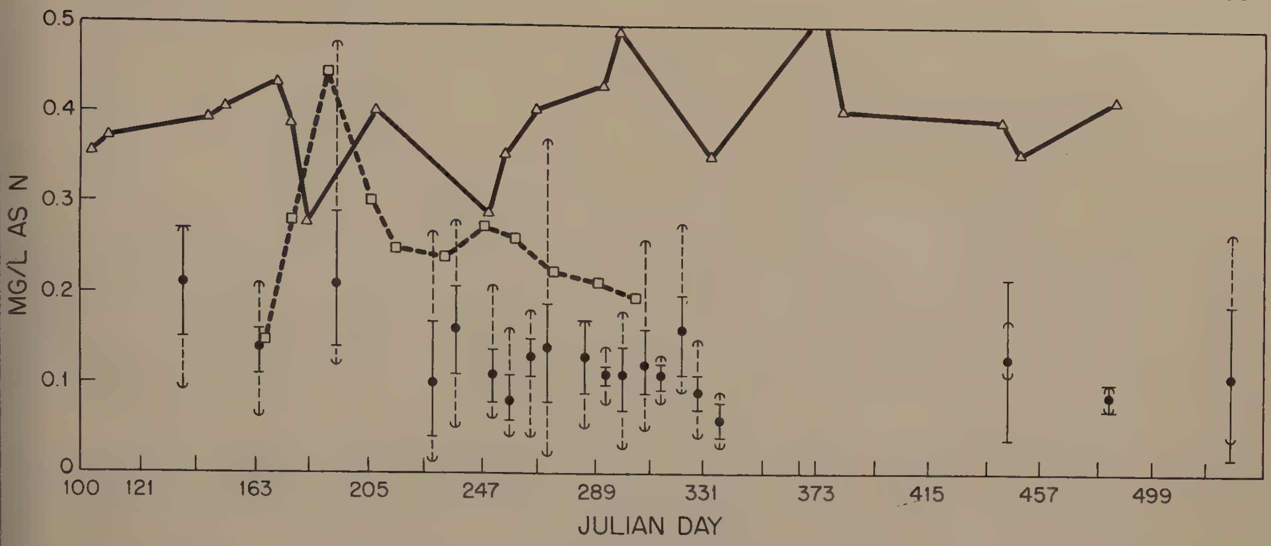

Figure 10.--Total Kjeldahl nitrogen.

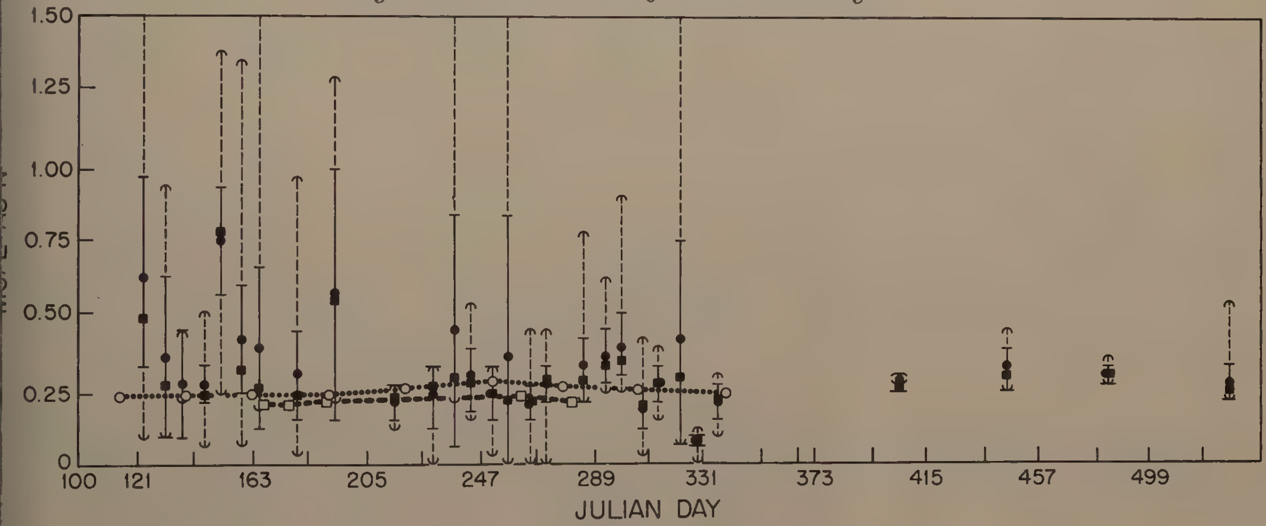

Figure 11.--Dissolved nitrite/nitrate.

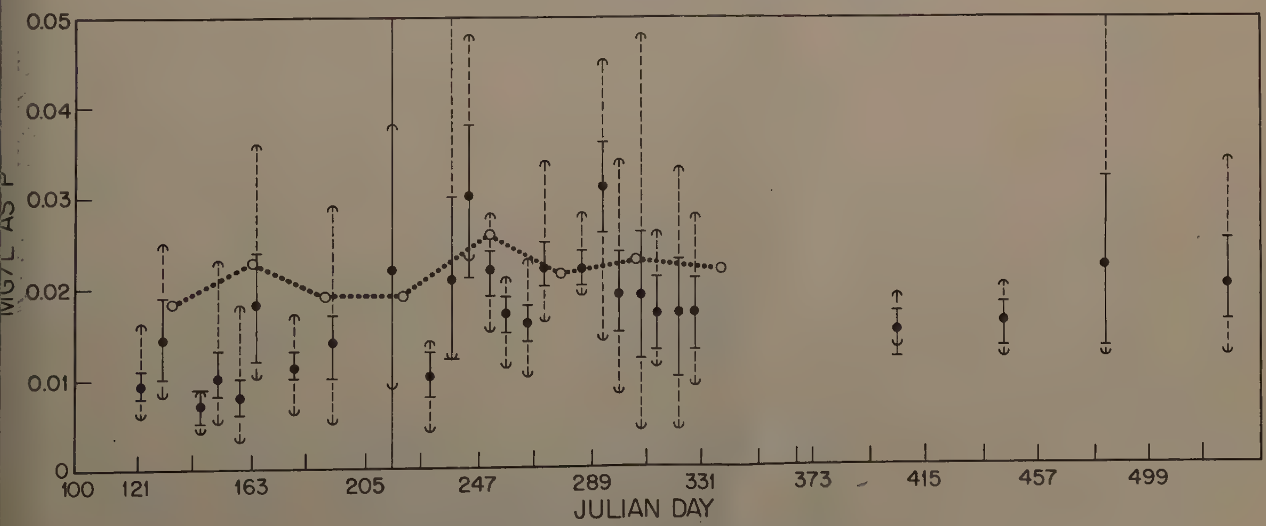

Figure 12.--Total phosphorus.

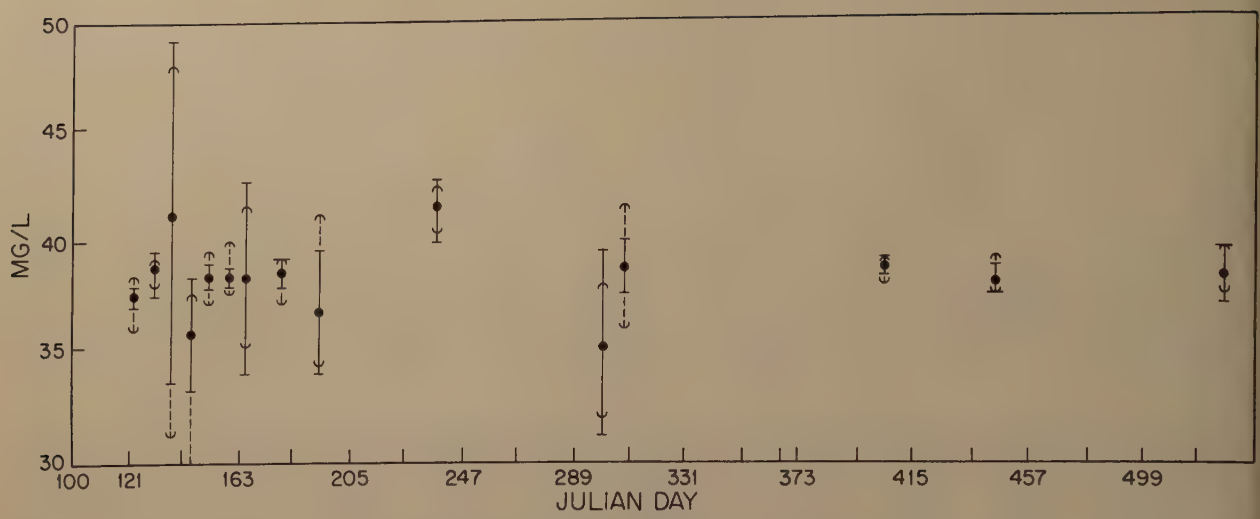

Figure 16.--Dissolved calcium.

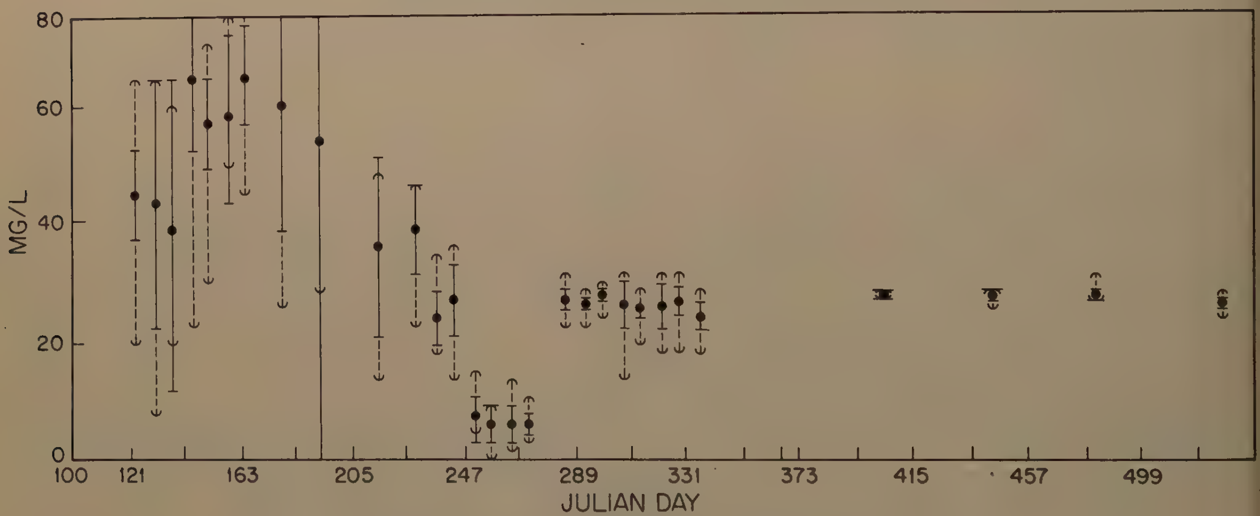

Figure 17.--Dissolved sulphate.

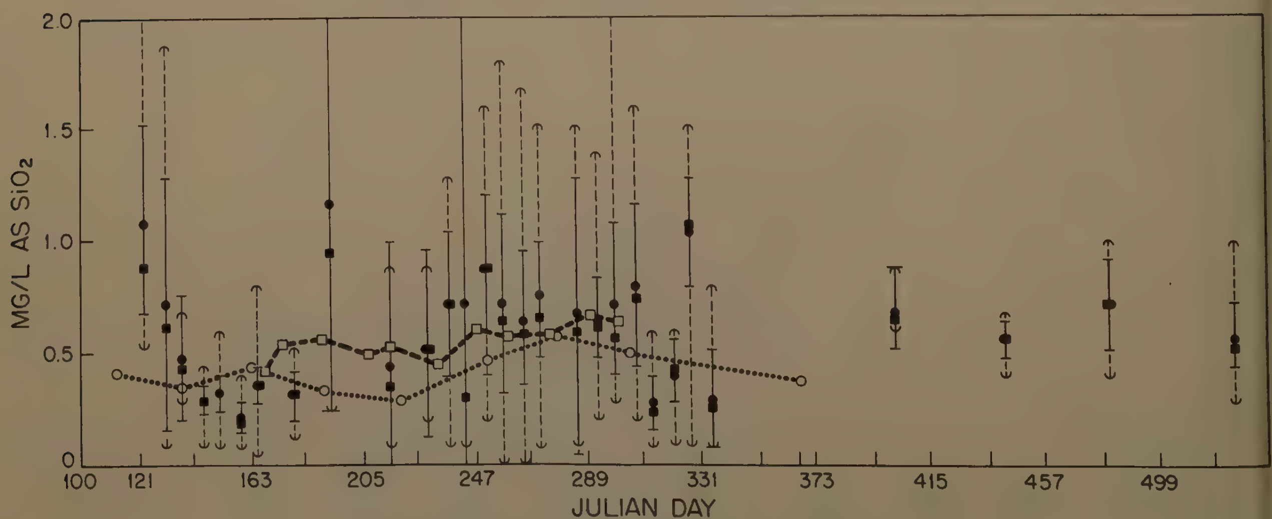

Figure 18.--Dissolved silicate.

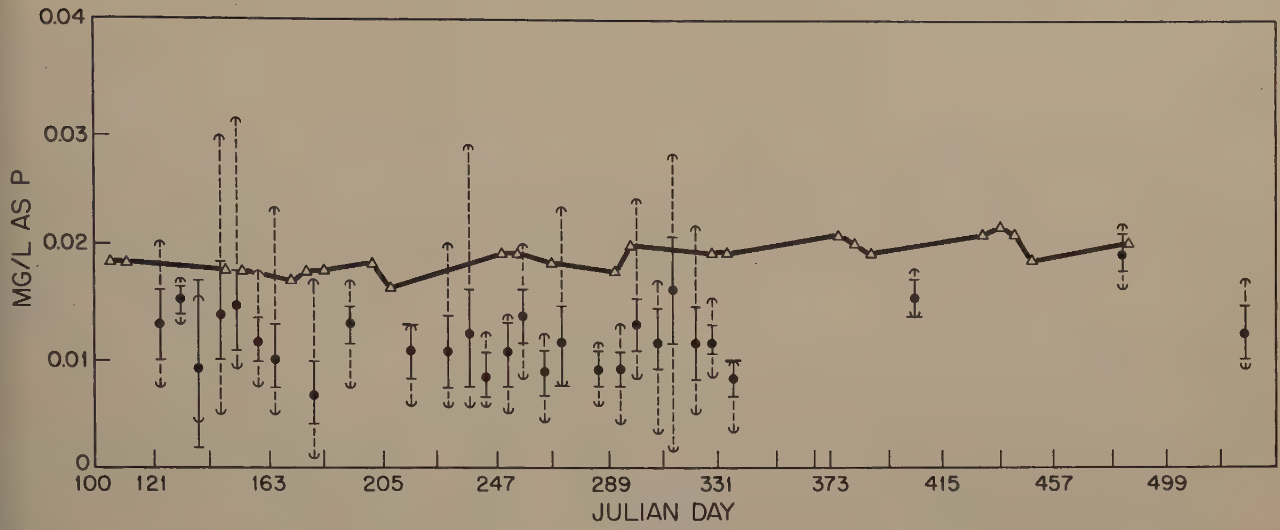

Figure 13.--Dissolved phosphorus.

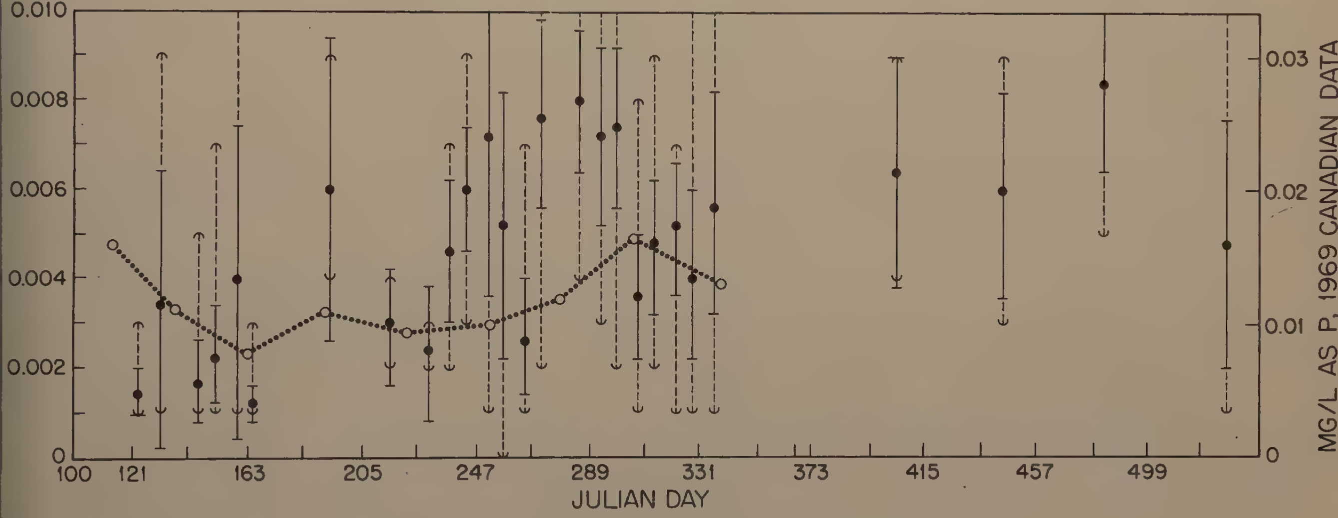

Figure 14.--Dissolved orthophosphate.

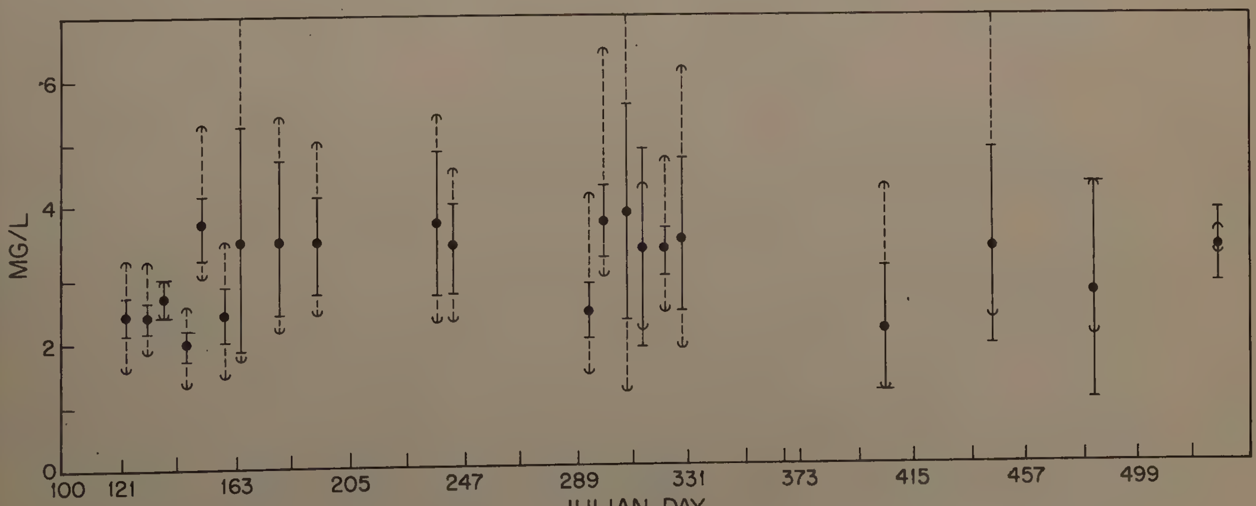

Figure 15.--Total organic carbon.

U.S. SCIENTIFIC PROGRAM

The reports below cover the period from October 1, 1976, through June 30, 1977. Completed tasks are listed first, followed by progress reports on tasks still active. References to task reports are contained in the bibliography in the first section of this issue. IFYGL Archive contents are listed in the final section.

Previously Completed Tasks

1. *Phosphorus Release and Uptake by Lake Ontario Sediments*

   Principal Investigators: D. E. Armstrong and R. F. Harris - University of Wisconsin

2. *Net Radiation*

   Principal Investigator: M. A. Atwater - CEM

3. *RFF/DC-6 Boundary Layer Fluxes*

   Principal Investigator: B. R. Bean - ERL/NOAA

4. *Nitrogen Fixation*

   Principal Investigator: R. Burris - University of Wisconsin

7. *Material Balance of Lake Ontario*

   Principal Investigator: D. J. Casey - EPA

8. *Runoff*

   Principal Investigator: L. T. Schutze - U.S. Army Corps of Engineers

9. *Evaporation (Lake-Land)*

   Principal Investigator: L. T. Schutze - U.S. Army Corps of Engineers

10. *Simulation Studies and Analyses Associated With the Terrestrial Water Balance*

    Principal Investigator: B. G. DeCooke - U.S. Army Corps of Engineers

12. *Transport Processes Within the Rochester Embayment of Lake Ontario*

    Principal Investigator: J. H. Thomas - University of Rochester

13. *Soil Moisture and Snow Hydrology*

Principal Investigator: W. N. Embree - U.S. Geological Survey

14. *Boundary Layer Structure and Mesoscale Circulation*

Principal Investigator: M. A. Estoque - University of Miami

15. *Mesoscale Simulation Studies*

Principal Investigator: M. A. Estoque - University of Miami

16. *Water Transfer Across Large Lake*

Principal Investigator: H. W. Stoughton - State University of New York at Alfred

17. *Nearshore Ice Formation, Growth, and Decay*

Principal Investigator: J. Dilley - General Electric Company

19. *Occurrence and Transport of Nutrients and Hazardous Polluting Substances in the Genesee River Basin*

Principal Investigator: L. J. Hetling - New York State Department of Environmental Conservation

21. *Hazardous Material Flow*

Principal Investigator: G. F. Lee - University of Texas at Dallas

22. *Remote Measurement of Chlorophyll With Lidar Fluorescent System*

Principal Investigator: H. H. Kim - NASA

23. *Inflow/Outflow Term - Terrestrial Water Budget*

Principal Investigator: P. L. Cox - U.S. Army Corps of Engineers

24. *Use of an Unsteady State Flow Model To Compute Continuous Flow*

Principal Investigator: P. L. Cox - U.S. Army Corps of Engineers

25. *Radiant Power, Temperature, and Water Vapor Profiles Over Lake Ontario*

Principal Investigator: P. M. Kuhn - ERL/NOAA

26. *Algal Nutrient Availability and Limitation in Lake Ontario*

Principal Investigator: G. F. Lee - University of Texas at Dallas

28. *Cloud Climatology*

Principal Investigator: W. A. Lyons - University of Wisconsin, Milwaukee

29. *Zooplankton Production in Lake Ontario as Influenced by Environmental Perturbations*

Principal Investigator: D. C. McNaught - State University of New York at Albany

31. *Soil Moisture*

Principal Investigator: L. T. Schutze - U.S. Army Corps of Engineers

32. *Testing of COE (Corps of Engineers) Lake Levels Model*

Principal Investigator: E. Megerian - U.S. Army Corps of Engineers

33. *Nearshore Study of Eastern Lake Ontario*

Principal Investigator: R. B. Moore - State University of New York at Oswego

34. *Internal Waves - Transects Program - Interpretation of Whole-Basin Oscillations*

Principal Investigator: C. H. Mortimer - University of Wisconsin, Milwaukee

35. Pontoporeia affinis *and Other Benthos in Lake Ontario*

Principal Investigator: S. C. Mozley - University of Michigan

37. *Simulation Studies and Other Analyses Associated With U.S. Water Movements Projects*

Principal Investigators: J. P. Pandolfo and C. A. Jacobs - CEM

38. *Structure of Turbulence*

Principal Investigator: H. A. Panofsky - Pennsylvania State University

39. *Airborne Snow Reconnaissance*

Principal Investigator: E. L. Peck - NWS/NOAA

40. *Optical Properties of Lake Ontario*

Principal Investigator: K. R. Piech - Calspan Corporation

44. *Oswego Harbor Studies*

Principal Investigator: G. L. Bell - GLERL/NOAA

45. *Mapping of Standing Water and Terrain Conditions With Remote Sensor Data*

Principal Investigator: F. C. Polcyn - ERIM

46. *Remote Sensing for the Determination of* Cladophora *Distribution*

Principal Investigators: F. C. Polcyn and C. T. Wezernak - ERIM

47. *Remote Sensing Study of Suspended Inputs Into Lake Ontario*

Principal Investigators: F. C. Polcyn and C. T. Wezernak - ERIM

49. *Lake Circulation, Including Internal Waves and Storm Surges*

Principal Investigator: D. B. Rao - GLERL/NOAA

52. *Groundwater Flux and Storage*

Principal Investigator: E. C. Rhodehamel - U.S. Geological Survey

53. *Spring Algal Bloom*

Principal Investigator: A. Robertson - GLERL/NOAA

54. *Ice Studies for Storage Term - Energy Balance*

Principal Investigator: F. H. Quinn - GLERL/NOAA

57. *Phytoplankton Nutrient Bioassays in the Great Lakes*

Principal Investigator: C. Schelske - University of Michigan

58. *Runoff Term of Terrestrial Water Budget*

Principal Investigator: G. K. Schultz - U.S. Geological Survey

59. *Coastal Chain Program*

Principal Investigator: J. T. Scott - State University of New York at Albany

60. *Analysis of Phytoplankton Composition and Abundance*

Principal Investigator: E. F. Stoermer - University of Michigan

61. *Clouds, Ice, and Surface Temperature*

    Principal Investigator: A. E. Strong - NESS/NOAA

62. *Analysis and Model of the Impact of Discharges From the Niagara and Genesee Rivers on Nearshore Biology and Chemistry*

    Principal Investigator: R. A. Sweeney - State University of New York at Buffalo

63. *NCAR/DRI - Buffalo Program*

    Principal Investigator: J. W. Telford - Desert Research Institute, University of Nevada

64. *Mathematical Modeling of Eutrophication of Large Lakes*

    Principal Investigator: R. V. Thomann - Manhattan College

65. Cladophora *Nutrient Bioassay*

    Principal Investigator: G. F. Lee - University of Texas at Dallas

68. *Exploration of Halogenated Hazardous Chemicals in Lake Ontario*

    Principal Investigators: G. F. Lee - University of Texas at Dallas
    C. L. Haile - University of Wisconsin

69. *Basin Precipitation - Land and Lake*

    Principal Investigator: J. W. Wilson - CEM

70. *Evaluation of ERTS Data for Certain Hydrological Uses*

    Principal Investigators: D. R. Wiesnet and D. F. McGinnis - NESS/NOAA

71. *Distribution, Abundance, and Composition of Invertebrate Fish Forage Organisms in Lake Ontario*

    Principal Investigator: R. F. Heberger, Jr. - Great Lakes Fisheries Laboratory

73. *Lake Water Characteristics*

    Principal Investigator: A. P. Pinsak - GLERL/NOAA

74. *Snow Observation Network*

    Principal Investigator: R. B. Sykes, Jr. - State University of New York at Oswego

Tasks Active in 1977

5. *Profile Mast and Tower Program*

Principal Investigator: J. A. Businger - University of Washington

Computation of eddy correlation fluxes from the Rochester tower data is complete. These data have been examined for local free convection behavior and the results are found to correspond quite closely with results previously published.

A simple model is being developed for the modification of the planetary boundary layer over the lake during episodes with cold air passing over the relatively warm lake. The model predicts vertically averaged boundary layer parameters and follows the mean air flow to obtain the time-fetch evolution of the air properties. Model constants will be evaluated based on the Wangara data and model results compared with data from the October intensive period of IFYGL. The relative importance of horizontal convergence, entrainment across the inversion, baroclinicity (sea breeze), and nonsteady-state conditions at the windward shore will be evaluated. Preliminary findings show that solutions to the model can be divided into two parts: a long-fetch solution that is independent of conditions at the upwind shore, and a transient solution that is a decaying inertial oscillation of the actual wind around the long-fetch solution and is necessary to satisfy the boundary conditions to the flow at the upwind shore.

Initial results from the model will be presented at the International Association for Meteorology and Atmospheric Physics Conference in Seattle, August 26, 1977. Work done under this task will be reported upon in a Ph.D. thesis from the University of Washington by Steven A. Stage, expected to be completed before the end of 1977.

6. *Status of Lake Ontario Fish Populations*

Principal Investigator: J. H. Kutkuhn - Great Lakes Fisheries Laboratory

Manuscripts describing the following studies have been completed and are in various stages of review:

"Age, Growth, and Food Habits of Northern Pike in Eastern Lake Ontario, 1972-73," by D. R. Wolfert and T. J. Miller.

"Diet of White Perch, Yellow Perch, and Rock Bass in Eastern Lake Ontario, 1972-73," by W-D. N. Busch, J. H. Elrod, B. L. Griswold, C. Schneider, and D. R. Wolfert.

"Age and Growth of White Perch in Lake Ontario, 1972-73," by W-D. N. Busch, and J. Heinrich.

"An Annotated List of the Fishes of the Lake Ontario Watershed," by E. J. Crossman and H. D. Van Meter.

"Survey of Lake Ontario Offshore Fish Stocks During the International Field Year of the Great Lakes (IFYGL) 1972," by R. O'Gorman, A. Larsen, and J. H. Kutkuhn.

"Food of Rainbow Smelt and Alewives in Lake Ontario, 1972," by R. F. Heberger.

"Checklist of Fishes From Lake Ontario and Its Tributary Waters," by H. D. Van Meter and E. J. Crossman (prepared for IFYGL report on the biota of Lake Ontario, May 1977).

11. *Land Precipitation Data Analysis*

Principal Investigator: J. R. Weiser - U.S. Army Corps of Engineers

The first draft of the project report is being prepared and has not yet been submitted for review as reported in IFYGL Bulletin 19.

18. *Advection Term - Energy Balance*

Principal Investigator: J. Grumblatt - LSC/NOAA

No progress during this period.

20. *Boundary Layer Flux Synthesis*

Principal Investigator: J. A. Almazan - CEDDA/NOAA

The final report has been submitted for review.

27. *Wave Studies*

Principal Investigator: P. C. Liu - GLERL/NOAA

A summary report on the IFYGL surface wave studies appears earlier in this Bulletin.

Two other IFYGL-related wave studies are in progress: a chapter on wave statistics to be included in the "IFYGL Atlas," and a report entitled "Temporal Spectral Growth and Nonlinear Characteristics of Wind Waves in Lake Ontario." Both studies are expected to be completed in 1977.

30. *Change in Lake Storage Term - Terrestrial Water Budget*

Principal Investigator: R. Wilshaw - U.S. Army Corps of Engineers

No activity during this period.

36. *Pan Evaporation Project*

Principal Investigators: C. N. Hoffeditz - NWS/NOAA
J. A. W. McCulloch - AES, Canada

No report.

41. *Storage Term - Energy Balance Program*

Principal Investigator: A. P. Pinsak - GLERL/NOAA

The major effort has been in resolving differences between temperature profiles and heat storage estimates derived from nine-point digitization of x-y traces and from magnetic tape profiles. This has led to extensive editing of the archived ship tapes, principally by filtering, applying proper scale corrections, and correcting locators.

Comparison of various types of measurements and techniques used in storage estimates, correlation with scanty calibration controls, confidence tests, error analyses, and stability at varying time and space scales are included in the summary scientific report.

42. *Sensible and Latent Heat Flux*

Principal Investigator: A. P. Pinsak - GLERL/NOAA

This task is complete. Various techniques for partitioning sensible and latent heat have been compared and results have been incorporated into the Energy Budget Summary Scientific Report.

43. *Thermal Characteristics of Lake Ontario and Advection Within the Lake*

Principal Investigator: A. P. Pinsak - GLERL/NOAA

Results of Task 41 is the basic input to this task so analysis is still in progress.

48. *Island-Land Precipitation Data Analysis*

Principal Investigator: F. H. Quinn - GLERL/NOAA

Analysis of the eastern island data shows severe gage undercatch. Extensive future analysis is not planned since the data appear to be unrepresentative. A short report will be prepared within the next several months depending on manpower availability.

50. *Atmospheric Water Balance*

Principal Investigator: E. M. Rasmusson - CEDDA/NOAA

The final report is in review.

51. *Evaporation Synthesis*

Principal Investigator: F. H. Quinn - GLERL/NOAA

All evaporation estimates, except for pan evaporation, have been received. An executive overview of the task has been prepared. Work is proceeding on the final scientific report.

55. *Lagrangian Current Observations*

Principal Investigator: J. H. Saylor - GLERL/NOAA

This task is inactive. Charts of alongshore current velocities measured during IFYGL are available from the principal investigator.

56. *Circulation of Lake Ontario*

Principal Investigator: J. H. Saylor - GLERL/NOAA

A summary of Lake Ontario circulation observed during IFYGL is being prepared as part of the Water Movement Program Scientific Report.

66. *Sediment Oxygen Demand*

Principal Investigator: N. A. Thomas - EPA

An interim draft of the report is available. Further work is continuing based on review comments.

67. *Main Lake Macrobenthos*

Principal Investigator: N. A. Thomas - EPA

A draft of the report is in preparation and should be available in October 1977.

72. *Coastal Circulation in the Great Lakes*

Principal Investigator: G. T. Csanady - Woods Hole Oceanographic Institution

The major effort in this final contract year of IFYGL data analysis and interpretation has been the synthesis into a coherent framework of several conceptual models relating to transient flow episodes. This work has resulted in a review article entitled "Water Circulation and Dispersal Mechanisms," which will be published in a coming Springer and Verlag volume, "Lakes, Their Physics and Chemistry," ed. A. Lerman.

The problem of the mean lake circulation was the focus of further data analysis and conceptual model building. In an article entitled "The Arrested Topographic Wave" a heat conduction analogy is applied to flow with friction

over a sloping coast. This model is found to account for the winter mean circulation in Lake Ontario, as well as for some features of the summer circulation, which is, however, more complex. This article should appear in due course in the Journal of Physical Oceanography.

Another conceptual model idealizes shoreward transport of heat by Ekman drift during the heating season. This transport produces a nearshore concentration of warm water and a cyclonic mean circulation component in geostrophic equilibrium with the corresponding pressure field. The model and data analysis have been described in an article entitled "On the Cyclonic Mean Circulation of Large Lakes" published in Proceedings of the National Academy of Sciences, Washington, D.C., Vol. 74, June 1977, pp. 2204-2208.

A final contribution, jointly with J. T. Scott, to this series on the mean circulation problem deals with the interpretation of the arithmetic mean circulation of Alert 2 of the IFYGL coastal chain program in terms of different conceptual models. The south shore circulation is well represented by a steady baroclinic flow model, but the north shore flow cannot be understood without invoking other models, including the arrested topographic wave. This paper is now in preparation.

75. *Lake Circulation Model*

Principal Investigator: J. R. Bennett - Massachusetts Institute of Technology

A summary report of the results of work on this task appears in the beginning of the United States section of this Bulletin.

76. *Lake Ontario Invertebrate Fauna List*

Principal Investigator: A. Robertson - GLERL/NOAA

Work is continuing on the estimates of abundance of each of the species and the biomass estimates for each of the more abundant forms, the final phase of this task.

77. *Distribution and Variability of Physical Lake Properties*

Principal Investigator: R. L. Pickett and S. Bermick - GLERL/NOAA

The activities during this period have culminated in several journal articles on task results. Parts of the Water Movement Program Final Scientific Report were prepared, which include these results.

78. *Carbon Cycle Model*

Principal Investigators: A. Robertson and B. Eadie - GLERL/NOAA

An ecological model of one spatial dimension was developed to meet two distinct objectives. The first was to gain insight into the functional rela-

tions in the Lake Ontario ecosystem and to identify areas where our knowledge is most deficient. This identification will be used to establish research needs and to set priorities. The second, long-range, objective was to begin the development of models to aid resource managers. Because ecological modeling has already shown great promise for application to resource management problems, it is hoped that the model reported here will be the first step in the development of a series of ecological models that can provide managers with predictions of the environmental consequences of alternate courses of action or inaction.

As it now exists, the model describes the dynamics of four types of phytoplankton, six types of zooplankton, detritus, organic nitrogen, ammonia, nitrate, available phosphorus, the carbonate system, and benthic invertebrates for the Lake Ontario ecosystem. The ecological model is driven by a physical model designed to predict average temperature, segment thicknesses, and vertical diffusion coefficients for the three-layer model.

An original formulation for calculating sedimentation rates has been shown to accurately predict community settling rates. The simulated processes and predicted variables follow ecologically realistic patterns and compare favorably to measured parameters in Lake Ontario.

Sensitivity analyses have revealed that modeled phosphorus is quite responsive to changes in diffusion, sedimentation is critical to predicting benthic dynamics, and self-shading by phytoplankton is not critical, because of the relationship between light limitation and phosphorus depletion. Changes in temperature resulted in predicted shifts in the peaks of the phytoplankton and zooplankton, and the sensitivity of the model to fish predation indicated the need for better descriptions of fish dynamics.

The following publications have resulted from this task:

Eadie, B. J., and A. Robertson, "An IFYGL Carbon Budget for Lake Ontario," Journal of Great Lakes Research, Vol. 2, 1976, pp. 307-333.

Robertson, A., and B. J. Eadie, "A Carbon Budget for Lake Ontario," Verhandlungen Internationale Vereinigung fur Theoretische und Angewandte Limnologie, Vol. 19, 1975, pp. 291-299.

Scavia, D., B. J. Eadie, and A. Robertson, "An Ecological Model for the Great Lakes," Proceedings of the Conference on Environmental Modeling and Simulation, ed. W. T. Ott, U.S. Environmental Protection Agency, Washington, D.C., 1976, pp. 629-633.

Scavia, D., B. J. Eadie, and A. Robertson, "An Ecological Model for Lake Ontario: Model Formulation, Calibration, and Preliminary Evaluation," NOAA Technical Report ERL 371-GLERL 12, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Boulder, Colorado, 1976, 63 pp.

Panel Reports

Terrestrial Water Balance Panel - B. G. DeCooke, U.S. Panel Cochairman
D. F. Witherspoon, Canadian Panel Cochairman

The manuscript of the Summary Scientific Report has been through external review and modification and is being edited. A draft report has been prepared for the IFYGL Wrap-Up Workshop.

Biology and Chemistry Panel - N. A. Thomas, U.S. Panel Cochairman
W. J. Christie, Canadian Panel Cochairman

Drafts of the "Status of Lake Ontario Biota" and the "Materials Balance" for the Summary Scientific Report are in final preparation. Copies of the final drafts of these sections should be available for the Wrap-Up Workshop.

Lake Meteorology Panel - E. M. Rasmusson, U.S. Panel Cochairman
D. W. Phillips, Canadian Panel Cochairman

The Precipitation Project report has been published in the special edition of IFYGL Bulletin No. 21. The Atmospheric Water Balance Project report has been submitted to the scientific editors in manuscript form for review. The Basin-Wide Meteorological Analyses report is in the final stages of preparation. Work is in progress on a report for the IFYGL Wrap-Up Workshop.

Boundary Layer Panel - J. Z. Holland, U.S. Panel Cochairman
F. C. Elder, Canadian Panel Cochairman

The manuscript of the Summary Scientific Report is under review by the scientific editors. Work is proceeding on a report for the IFYGL Wrap-Up Workshop.

Water Movements Panel - J. H. Saylor, U.S. Panel Cochairman
E. B. Bennett, Canadian Panel Cochairman

Work is proceeding on the Summary Scientific Report.

Energy Budget Panel - A. P. Pinsak, U.S. Panel Cochairman
G. K. Rodgers, Canadian Panel Cochairman

A draft of the Summary Scientific Report is being prepared.

Evaporation Synthesis Panel - F. H. Quinn, U.S. Panel Cochairman
G. den Hartog, Canadian Panel Cochairman

A draft of the Summary Scientific Report is near completion.

DATA MANAGEMENT - IFYGL ARCHIVE

Tables 3 and 4 on the following pages summarize the data collected during IFYGL. They are arranged by country and task number. Task titles are capitalized. The numbered lines refer to types of data or reports from those tasks. The components of the tables are:

TASK NO. - The numbers assigned for IFYGL project identification.

PANEL ABBREVIATION - These are as follows (asterisks indicate tasks grouped for convenience, not true scientific panels):

AB - Atmospheric Boundary Layer
BC - Biology and Chemistry
EB - Energy Balance
*FS - Field Support (Canada)
LM - Lake Meteorology and Evaporation (U.S.)
ME - Lake Meteorology and Evaporation (Canada)
*MS - Major Systems (U.S.)
*SD - Supplementary or Standard Data
TW - Terrestrial Water Balance
WM - Water Movement

TASK AND PRINCIPAL INVESTIGATORS' NAMES - If there were more than one investigator for a task, the first was selected for inclusion here. The investigators of some tasks changed through the years; consequently, the ones given here might not have been active during the Field Year of 1972-1973.

LINE NUMBER AND DATA DESCRIPTION - The task and line numbers are major components of the data catalog numbers. The data managemant system became "locked into" the line numbers early in the archiving process; thus line numbers were occasionally skipped. For example, note that in USA Task 5 there is no line 4.

QUANTITY-MEDIA - These are generally self-explanatory. Microfilm is in increments of 100-ft reels; however, most reels are not entirely filled. Punched cards are given in quantities of "sets" of cards rather than in numbers of punched cards.

STATUS - This describes the availability and location of the data, as follows:

"In Archive" means that the data are on file at the National Climatic Center, and will be archived permanently.

"Temporary Archive" means that the data are at the National Climatic Center, but are not needed permanently. These data will be kept as long as they are likely to be needed by investigators.

"Retained by P.I." means that the data are not at the National Climatic Center, but are in the files of the Principal Investigator, who should be contacted if the data are needed.

"Not Archived" means that the data were not filed in this form. The data are usually available in a more convenient form.

"To be Archived" means that the data had not been received at the National Climatic Center at the time of this listing, but are expected in the future. If received, the material will be filed as received from the Principal Investigator.

"For Security" means that the data are held in this form as insurance against the loss of the data in another form.

"In NCC Files" means that the data were not generated for the IFYGL project and, thus, are not in the IFYGL Archive. However, they may be ordered from the National Climatic Center as supplementary data.

Visitors are welcome to the United States IFYGL Archive at the National Climatic Center in Asheville, North Carolina. Data from the microforms may be extracted without charge. Copies of data can be obtained for the cost of duplication.

For further information, or cost estimates, contact:

IFYGL Data Manager, Room 17
National Climatic Center, EDS, NOAA
Federal Building
Asheville, NC 28801

Telephone: 704 258-2850, Ext. 754; FTS: 672-0754

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
1 BC SEDIMENT ANALYSIS (Armstrong)		
1. Phosphorus - Core Sample Results	Pages	Not Archived
2. Phosphorus Uptake - Release by Sediments	2 Microfiche	In Archive
2 EB NET RADIATION (Atwater)		
1. Interim Reports	4 Microfiche	In Archive
2. Net Radiation Data for Grid	1 Magnetic Tape	In Archive
3. Final Report - Cloud Cover Radiation - Vol. I - Program Specs. - Vol. II	4 Microfiche	In Archive
3 AB RFF/DC-6 (GUST PROBE) (Bean)		
1. Raw Turbulence Data	60 Magnetic Tapes	Not Archived
2. Reduced Turbulence Data - Binary	30 Magnetic Tapes	Not Archived
3. Reduced Turbulence Data - Digital	7 Magnetic Tapes	In Archive
4. Computed Flux, Time Series Spectra	17 Microfilm	In Archive
5. Time Series Graphics (U,V,W,T,PV)	2 Microfilm	In Archive
6. Means, Variances and Fluxes	1 Microfilm	In Archive
7. Plots of Flight Paths	1 Microfiche	In Archive
8. Spatial - Temporal Variations in Turbulence Fluxes	2 Microfiche	In Archive
4 BC NITROGEN FIXATION (Burris)		
1. Nitrogen Fixation Rates (Ship)	Pages	Not Archived
2. Final Report	1 Microfiche	In Archive
5 AB PROFILE MAST AND TOWER (Businger)		
1. Raw Meteorological (Cobourg)	80 Analog Mag Tapes	Not Archived
2. Raw Meteorological (Rochester)	40 Magnetic Tapes	Not Archived
3. Edited Meteorological (Cobourg) Time Series 4/Sec.	2 Magnetic Tapes	Not Archived
5. Computed Profile and Flux Data, 15 Minute and Hourly Averages	1 Magnetic Tape	In Archive
6. Report - Profile Measurements in Atmospheric Surface Layer	2 Microfiche	In Archive
7. Eddy Correlation Fluxes	1 Magnetic Tape	To be Archived
6 BC STATUS OF FISH POPULATION (Kutkuhn)		
1. Fish Samples - Size, Numbers, Scale Collections (From punched cards)	1 Cards-Tape	In Archive
2. Fish Samples - Size, Numbers, Scale Collections (From punched cards)	1 Listing	Temporary Archive
3. Water Temperature (BT) (From punched cards)	1 Cards-Tape	In Archive
4. Digitized BT, 5 Fathoms	1 Listing	Temporary Archive
5. RESEARCHER Fathometer (Echo Sounding)	60 Rolls	Retained by P.I.
6. Final Report	1 Report	To be Archived
7 BC MATERIAL BALANCE (Casey)		
1. Material Balance Data in STORET (Task 110, Lines 3 & 5)	STORET	In Archive
2. Water Sample Chemical Analysis	Pages	Not Archived
3. Final Report - Streams	1 Microfiche	To be Archived
4. Final Report - Main Lake	1 Microfiche	To be Archived
5. Empirical Model for Nutrient Accumulation Rates	1 Microfiche	In Archive

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
8 TW RUNOFF (Schutze)		
1. Weekly Streamflow Data	1 Microfiche	To be Archived
2. Summary Report	1 Microfiche	To be Archived
9 TW EVAPORATION (LAKE-LAND) (Schutze)		
1. Weekly Evaporation Estimates	1 Microfiche	To be Archived
2. Final Report	1 Microfiche	To be Archived
10 TW SIMULATION STUDIES (DeCooke)		
1. Final Report	1 Microfiche	To be Archived
11 TW LAND PRECIPITATION (Weiser)		
1. Monthly Precip. Estimates - US Basin	1 Microfiche	To be Archived
2. Final Report	1 Microfiche	To be Archived
12 BC ROCHESTER EMBAYMENT STUDY (Thomas)		
1. Chemical Data	100 Pages	Not Archived
2. Chemical Data	1 Magnetic Tape	Retained by P.I.
3. Current Speed and Direction, Water Temperature, Wind	7 Microfilm	Not Archived
4. Current, Water Temperature, Wind	1 Magnetic Tape	In Archive
5. Water Temperature - Analog	10 Strip Charts	Not Archived
7. Beach Stations - Chemical Data	90 Pages	Not Archived
8. Beach Stations - Wind Data	Strip Charts	Not Archived
10. Gravity Magnetic Survey	5 Magnetic Tapes	Retained by P.I.
11. RESEARCHER Fathometer Soundings	1 Strip Chart	Retained by P.I.
12. Final Report	9 Microfiche	In Archive
13 TW SOIL MOISTURE AND SNOW HYDROLOGY (Embree)		
1. Soil Moisture Neutron Probe Charts	1 Microfilm	In Archive
2. Soil Moisture Tabulated Data	3 Microfiche	In Archive
3. Snow Depth - Water Equivalent	1 Microfiche	In Archive
4. Observation Well Data	1 Microfiche	In Archive
5. Final Report - Soil Moisture	1 Microfiche	In Archive
14 AB BOUNDARY LAYER STRUCTURE AND MESOSCALE CIRCULATION (Estoque)		
1. Land Meteorological Stations - Surface Meteorological Data	300 Strip Charts	Retained by P.I.
2. Tethered Balloon (Blip - Meteorological Data)	Strip Chart	Not Archived
3. Tethered Balloon (Blip)	3 Microfilm	In Archive
4. NCAR Queen Air Aircraft - Raw Meteorological Data	Mag Tape	Not Archived
5. NCAR Queen Air ACFT - Processed Data	Mag Tape	Not Archived
6. NCAR Queen Air ACFT - Processed Data Listing - 1 Second Sample Rate	18 Microfilm	Retained by P.I.
7. Pibal Observations - Wind Components	1 Microfilm	In Archive
8. Cloud Cover Photography - Time Lapse	60 16mm Film	Retained by P.I.
9. " " " - Still	4000 Negatives	Retained by P.I.

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
15. MESOSCALE SIMULATION STUDIES (Estoque)		
1. Control of Mesoscale Disturbances	1 Microfiche	In Archive
2. Final Reports (3)	1 Microfiche	To be Archived
16 TW LAKE LEVEL TRANSFER (Stoughton)		
1. A Published Report is not Expected		Not Archived
17 EB NEARSHORE ICE FORMATION (Dilley)		
1. Meteorological Data - Automatic Van (Temperature, Wind, Radiation, Pressure)	15 Paper Tape	Not Archived
2. Meteorological Data Listing - Automatic Van (Temperature, Wind, Radiation, Pressure)	1 Microfilm	In Archive
3. Time Lapse Photography (Ice Formation)	500 Ft. Movie 8 Film	Retained by P.I.
4. Analysis of Lakeshore Ice Formation Growth, and Decay - IFYGL Phase 2	2 Microfiche	In Archive
5. Data Report	2 Microfiche	In Archive
18. EB ADVECTION TERM - ENERGY BALANCE (Grumblatt)		
1. Water Temperature - 5 Minute Intervals	Paper Tape	Not Archived
2. Water Temperature - 5 Minute Intervals	1 Mag Tape	In Archive
3. Final Report	1 Microfiche	To be Archived
19 BC TRANSPORT OF NUTRIENTS (Hetling)		
1. Nutrient Transport Data in STORET (Task 110, Line 7)	STORET	To be Archived
2. Stream Water Samples - Chemical Analysis	Pages	Not Archived
3. Final Report (Genesee Basin)	1 Microfiche	To be Archived
20 AB BOUNDARY LAYER FLUX SYNTHESIS (Almazan)		
1. Final Report	1 Microfiche	To be Archived
21 BC HAZARDOUS MATERIAL FLOW (Lee)		
1. Final Report	1 Microfiche	To be Archived
2. Water Samples - Chemical Analysis	Pages	Not Archived
3. Available Phosphorus in Urban Runoff	6 Microfiche	In Archive
22 BC REMOTE MEASUREMENT OF CHLOROPHYLL (Kim)		
1. Final Report	1 Microfiche	In Archive
23 TW OUTFLOW TERM TWB (Cox)		
1. Outflow Management	1 Magnetic Tape	In Archive
2. Final Report/Data Report	2 Microfiche	In Archive
24 TW FLOW MODEL (Cox)		
1. Final Report	1 Microfiche	To be Archived
26 BC ALGAL NUTRIENT AVAILABILITY (Lee)		
1. Lake and River Sample Worksheets	Pages.	Not Archived
3. Final Report	1 Microfiche	To be Archived

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
27 WM WAVERIDER BUOY (Liu)		
1. Raw Wave Data, Continuous Analog	31 Analog Tapes	Not Archived
2. Raw Wave Data	36 Strip Charts	Not Archived
3. Digitized Wave Data (3 Samples/Second)	30 Magnetic Tapes	In Archive
5. Hourly Summary and Plot of Digitized Wave Data	1 Microfilm	In Archive
6. Final Report	4 Microfiche	In Archive
7. Wave Spectra during Hurricane Agnes	1 Microfiche	In Archive
28 EB CLOUD CLIMATOLOGY (Lyons)		
1. Solar Radiation - Incident	45 Strip Charts	Retained by P.I.
2. Hourly Solar Radiation	1 Microfiche	In Archive
3. Cloud Photography - Color Panorama	3300 Frames 35mm	Retained by P.I.
4. " " - Color All Sky	6000 Ft. 16mm	Retained by P.I.
5. " " - Other	12000 Frames 35mm	Retained by P.I.
6. DAPP Satellite Imagery , Digitized Cloud Photographs, Cloud Cover Mosaics	300 Frames 70mm	Not Archived
7. Final Report	1 Microfiche	To be Archived
29 BC ZOOPLANKTON PRODUCTION (McNaught)		
1. Zooplankton Data in STORET (Task 110, Line 7)	STORET	To be Archived
2. Raw Acoustical Sounding Data	Paper Tape	Not Archived
3. Raw Acoustical Sounding Data	Magnetic Tape	Not Archived
4. Acoustical Profiles	Sheets	Retained by P.I.
5. Zooplankton Concentration Worksheets	Pages	Retained by P.I.
6. Final Report	1 Microfiche	To be Archived
30 TW LAKE STORAGE TERM (WATER LEVELS) (Wilshaw)		
1. Raw 5-Minute Water Levels	Paper Tape	Not Archived
2. 5-Minute Water Levels	1 Magnetic Tape	In Archive
3. Raw Hourly Water Levels	1 Magnetic Tape	To be Temp. Arch.
4. Edited (Converted to Common Datum) Hourly Water Levels	1 Magnetic Tape	In Archive
5. Final Report	1 Microfiche	To be Archived
31 TW SOIL MOISTURE (Schutze)		
1. Weekly Soil Moisture Data	1 Microfiche	To be Archived
2. Final Report	1 Microfiche	To be Archived
33 BC NEARSHORE STUDY (Moore)		
1. Nearshore Data in STORET (Task 110, Lines 3 & 5)	STORET	In Archive
2. River-Lake Chemical Analysis	Pages	Not Archived
3. Biological Analysis	1 Magnetic Tape	Not Archived
4. Temperature - Dissolved Oxygen Profiles	Pages	Not Archived
5. Final Report	1 Microfiche	To be Archived
34 WM INTERNAL WAVES - TEMPERATURE TRANSECT (Mortimer)		
1. Water Temperature/Depth - MBT	1100 Slides	Not Archived
2. " " - Undulator	18 Magnetic Tapes	Not Archived
4. X-Y Plots	120 Sheets	Not Archived
5. Temperature Transects	1 Microfilm	In Archive
6. Final Report	7 Microfiche	In Archive

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
7. Internal Wave Response of Thermocline to a Storm Passage	1 Microfiche	In Archive
8. Development of an Automatic Depth Profiling System	2 Microfiche	In Archive
35 BC BENTHOS STUDY (Mozley)		
1. Benthos Study Data in STORET (Task 110, Line 7)	STORET	To be Archived
2. Invertebrate Organism Sample Worksheets	Pages	Not Archived
3. EBT's - ADVANCE II Cruise 26 (3 graphs)	1 Microfiche	In Archive
4. Final Report	1 Microfiche	To be Archived
36 LM EVAPORATION PAN NETWORK (US AND CDN) (Hoffeditz)		
1. Radiation, Incident Long Wave and Short Wave Hourly Totals (From 800 punched cards)	1 Cards-Tape	To be Archived
2. Evaporation Pan Data (From 4800 punched cards)	1 Cards-Tape	To be Archived
3. Evaporation Pan Data (US and CDN)	170 Pages	Not Archived
4. Four Reports and Final Report Describing Results	1 Microfiche	To be Archived
37 WM SIMULATION STUDIES (Pandolfo)		
1. Final Report - Vol. I	3 Microfiche	In Archive
2. FORTRAN Program - Vol. II	2 Microfiche	In Archive
3. 1-Dimensional Model - Vol. III	1 Microfiche	In Archive
4. 3-Dimensional Model - Vol. IV	2 Microfiche	In Archive
38 AB TURBULENCE - NIAGARA BAR TOWER (Panofsky)		
1. Raw Wind Speed Fluctuations	100 Strip Charts	Not Archived
2. Raw Wind Speed Fluctuations	24 Analog Tapes	Not Archived
3. Reduced Wind Speed Fluctuations	6 Magnetic Tapes	Retained by P.I.
5. Two Point Statistics over Lake Ontario	2 Microfiche	In Archive
39 TW AIRBORNE SNOW RECONNAISSANCE (Peck)		
1. Gamma Radiation Flux Data Counts	1 Magnetic Tape	Not Archived
2. Ground Truth Data	1 Microfiche	In Archive
3. Airborne Survey Water Equivalent	1 Microfiche	In Archive
4. Soil Moisture Measurements	1 Microfiche	In Archive
5. Snow Cover Water Equivalents	1 Microfiche	In Archive
6. Water Equivalent - Air Survey	1 Microfiche	In Archive
7. Final Report (Task Summary)	1 Microfiche	To be Archived
40 EB LAKE OPTICAL PROPERTIES (Piech)		
1. Aerial Color Photography - Lake Volume Reflectance	700 Ft. 70mm Film	Not Archived
2. Turbidity Measurements - Irradiance Meter/Transmissometer - Manual Record	Pages	Not Archived
3. Turbidity Measurements - Graphs	500 Sheets	Retained by P.I.
4. Turbidity Measurements - Irradiance Meter/Transmissometer - Graphs	7 Microfiche	In Archive
5. Documentation - Location of Measurements, Final Report	1 Microfiche	To be Archived

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
41 EB LAKE HEAT STORAGE (Pinsak)		
1. Weekly Mean Water Temperatures for Lake Cells	1 Microfiche	To be Archived
2. Final Report	1 Microfiche	To be Archived
42 EB SENSIBLE AND LATENT HEAT FLUX (Pinsak)		
1. Final Report	1 Microfiche	To be Archived
43 EB LAKE THERMAL ADVECTION (Pinsak)		
1. Final Report	1 Microfiche	To be Archived
44 BC OSWEGO HARBOR STUDIES (SHENEHON) (Bell)		
1. Raw Meteorological	Paper Tape	Not Archived
2. Final Meteorological, 6-Minute Data	1 Magnetic Tape	In Archive
3. Solar Radiation, Incident and Reflected	51 Charts	Retained by P.I.
4. Chemical/BT Data Listing	2000 Pages	Not Archived
5. Chemical/Digitized BT (1 Meter)	1 Magnetic Tape	To be Archived
6. Final Report (Oswego Harbor)	1 Microfiche	To be Archived
45 TW REMOTE SENSING - TERRAIN (Polcyn)		
1. Scanning Radiometer - 12 Channels	45 Analog Tapes	Not Archived
2. Aerial Photography - Color (50' reels)	15 70mm Film	Retained by P.I.
3. " " - Black - White, (NASA)	1000 Film Prints	Retained by P.I.
4. " " - Black - White, (ERIM)	300 Film Negs.	Retained by P.I.
5. ERTS Digital Tapes from NASA	Magnetic Tape	Not Archived
6. ERTS-1 Investigation for Lake Ontario	2 Microfiche	In Archive
7. Aircraft Flight Data Record	2 Microfiche	In Archive
8. Analysis of Hydrological Features	2 Microfiche	In Archive
46 BC CLADOPHORA SENSING (Polcyn)		
1. Cladophora Distribution	2 Microfiche	In Archive
48 TW ISLAND - LAND PRECIPITATION (Quinn)		
1. Hourly Precipitation Amounts	Paper Tape	Not Archived
2. Hourly Precipitation Amounts	1 Magnetic Tape	In Archive
3. Precipitation - 84 NWS Stations	1 Magnetic Tape	In Archive
4. Daily Lake Ontario Basin Precipitation	1 Microfiche	In Archive
5. Overlake Precipitation Report	1 Microfiche	To be Archived
6. Overland Precipitation	1 Microfiche	In Archive
7. Eastern Lake Precipitation Network	1 Microfiche	In Archive
49 WM LAKE CIRCULATION (Rao)		
1. Final Report	1 Microfiche	To be Archived
50 LM ATMOSPHERIC WATER BALANCE (Rasmusson)		
1. Heat and Water Budget Computations	1 Microfiche	To be Archived
2. Final Report	1 Microfiche	To be Archived
51 TW EVAPORATION SYNTHESIS (Quinn)		
1. Final Report	1 Microfiche	To be Archived

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
52 TW GROUNDWATER WELLS (Rhodehamel)		
1. Water Levels - 1 Worksheet per Week/Month	30 Sheets	Not Archived
2. " " - Analog - Continuous	Strip Charts	Retained by P.I.
3. Data and Computation Sheets	2 Microfiche	In Archive
4. Provisional Report	1 Microfiche	In Archive
54 EB ICE STUDIES FOR STORAGE TERM (Quinn)		
1. Ice Studies Data Report	4 Microfiche	In Archive
A. Ice Thickness - Manual Measurement, 5 Sites, Weekly Data		
B. Ice Coverage Maps		
C. Surface Meteorological Data - Hourly		
D. Albedo Measurement		
55 WM LAGRANGIAN CURRENT OBSERVATIONS (Saylor)		
1. Current Drogue Daily Plot	Sheets	Retained by P.I.
2. Water Temperature-Daily Chart	Sheets	Retained by P.I.
3. " " -EBT X-Y Plot	200 Sheets	Not Archived
4. " " -Reversing Thermometer	550 Sheets	Not Archived
5. Final Report	1 Microfiche	To be Archived
56 WM CIRCULATION - CURRENTS (Saylor)		
1. Final Edited Current Data (From PDCS)	12 Magnetic Tapes	Not Archived
2. Current/Wind Daily Charts	40 Sheets	Retained by P.I.
3. Final Report	1 Microfiche	To be Archived
58 TW RUNOFF (Schultz)		
1. Tributary Stage Levels - Strip Charts (4 USGS Gages)	1 Microfilm	In Archive
2. " " " - 1 Ob/15 Min.-Digital	2 Magnetic Tapes	In Archive
Instructions	3 Microfiche	In Archive
3. " " " - Daily Data	Magnetic Tape	Retained by P.I.
4. " " " - Weekly Data	200 Cards	Temporary Archive
5. Mean Weekly Flow	1 Microfiche	In Archive
6. Tributary Stage and Discharge 35 Miscellaneous Sites - Intermittent	10 Microfiche	In Archive
7. New York Barge Canal Data	1 Microfiche	In Archive
8. Final Report	1 Microfiche	In Archive
59 WM COASTAL CHAIN (Scott)		
1. Current Meter Data, Water Temperature	1 Magnetic Tape	In Archive
2. Final and Basic Data Report	16 Microfiche	In Archive
3. Current Meter Data, Water Temperature	15000 Cards	Temporary Archive
60 BC PHYTOPLANKTON COMPOSITION AND ABUNDANCE (Stoermer)		
2. Samples - Particle Count Data	Pages	Not Archived
3. Data Count - Pre-Report	2 Microfiche	In Archive
4. Data Analysis - Lakewide Changes	2 Microfiche	In Archive
5. Phytoplankton Composition and Abundance	7 Microfiche	In Archive
61 EB CLOUDS,ICE & SURFACE TEMPERATURE-SAT. (Strong)		
1. NOAA-2 VHRR Digital Tapes	19 Magnetic Tapes	In Archive

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
2. NOAA-2 VHRR Images - 10x10 Prints	21 Films	Temporary Archive
3. Final Report - Utilizing NOAA Satellite Data	1 Microfiche	In Archive
4. ERTS-1 Imagery	Film	Not Archived
5. ERTS-1 Digital Tapes	Magnetic Tapes	Not Archived
62 BC RIVER DISCHARGE IMPACTS (Sweeney)		
1. Nearshore Bio-Chem STORET Data(Task 110, Lines 3, 5, & 7)	STORET	In Archive
2. Water Sample Chemical Analysis Worksheets	Pages	Not Archived
3. Sediment Sample Worksheets	Pages	Not Archived
4. Chlorophyll and Plankton Sample Worksheets	Pages	Not Archived
6. Final Report	1 Microfiche	To be Archived
63 AB NCAR/DRI AIRCRAFT (Telford)		
1. Raw Data - Gust Probe, Met. Sensors	20 Magnetic Tapes	Not Archived
2. Reduced Data - Gust Probe, Met Sensors	20 Magnetic Tapes	Retained by P.I.
3. Reduced Data (Time, Location, U,V,W, Temperature, Dew Point, Pressure)	20 Magnetic Tapes	Retained by P.I.
4. Reduced Data, CALCOMP Plot - Aircraft Track, 6-Sec. Wind Vectors	400 Sheets	Retained by P.I.
5. Final Data Report - Computed Fluxes of Momentum, Heat, Vapor (1/Minute)	1 Microfiche	To be Archived
6. Final Report - NCAR/Buffalo System	1 Microfiche	In Archive
7. Measurement of Wind: Instruments and Accuracy	2 Microfiche	In Archive
64 BC EUTROPHICATION MODEL (Thomann)		
1. Final Report	1 Microfiche	To be Archived
2. Modeling of Phytoplankton	1 Microfiche	In Archive
66 BC SEDIMENT OXYGEN DEMAND (Thomas)		
1. Sediment Oxygen Data in STORET (Task 110, Lines 3 & 5)	STORET	In Archive
2. Oxygen Data - Sediment Sample Worksheets	Pages	Not Archived
4. Final Report	1 Microfiche	To be Archived
67 BC LAKE MACROBENTHOS (Thomas)		
1. Distribution of Benthic Organisms	1 Microfiche	To be Archived
2. Sediment Particle Size, Composition	1 Microfiche	To be Archived
3. Final Report	1 Microfiche	To be Archived
4. Chlorophyll a Profiles	1 Microfiche	In Archive
68 BC HAZARDOUS CHEMICALS (Lee)		
1. Hazardous Chemical STORET Data (Task 110, Lines 3 & 5)	STORET	In Archive
2. Water and Sediment Samples - Chemical Analysis Worksheets	Pages	Not Archived
3. Fish Sample Worksheets	Pages	Not Archived
5. Final Report - Chlorinated Hydrocarbons	1 Microfiche	In Archive
69 TW RADAR AND PRECIPITATION GAGE NETWORK (Wilson)		
1. Raw Radar Data - Returned Echo Intensity - Edited	69 Magnetic Tapes	Temporary Archive

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
2. Radar Derived Hourly Precipitation	50 Magnetic Tapes	Not Archived
3. Photographs of Radar Scope - Buffalo & Oswego	106 Microfilm	In Archive
4. Daily Total Precipitation Amounts (Including Precipitation Gage Data)	1 Magnetic Tape	In Archive
5. Radar Documentation	150 Pages	Temporary Archive
6. Oswego Radar Event Logs	300 Pages	Temporary Archive
7. Raw Precipitation Data - Rochester Precipitation Network	189 Paper Tape	Temporary Archive
8. Documentation - Rochester Precipitation Network Observers' Logs	600 Pages	Temporary Archive
9. Raw Prec. Data - Weighing Gage (From NCC)	Strip Charts	Not Archived
10. Precipitation Data - Rochester Network	2 Magnetic Tapes	In Archive
11. Precipitation Data - Oswego Snow Network	1 Microfiche	In Archive
12. Radar Data Hourly Precipitation Amounts (By Storm, Genessee Basin Only)	1 Magnetic Tape	At GLERL
13. Average Daily Precipitation, Eastern Lake Ontario	1 Microfiche	In Archive
14. Collection and Analyses of Digitized Radar Data	1 Microfiche	In Archive
15. Final Report - Radar-Gage Precip. Measurments	3 Microfiche	In Archive
16. Final Report - Summary of the IFYGL Precipitation Project	1 Microfiche	In Archive
70 TW AERIAL HYDROLOGICAL SURVEY (Wiesnet)		
1. NASA U2 Photography - 6 Overflights	4 70mm Film	Not Archived
2. Multispectral Photography (Ames Res. Ctr.)	1 70mm Film	Not Archived
3. Aerial Radiological Measuring Survey	1 Magnetic Tape	Not Archived
4. Thermal IR Image Data	1 70mm Film	Not Archived
5. ERTS Digital Data, NOAA-2 VHRR, and ERTS Images	28 Magnetic Tapes	Not Archived
6. Raw Microwave Data (Aerojet Corp.)	4 Magnetic Tapes	Not Archived
7. Final Report - Evaluation of ERTS-1 Sat. Data	1 Microfiche	In Archive
71 BC INVERTEBRATE FISH FORAGE ORGANISMS (Heberger)		
1. Fish Food Habits Data (From 1450 cards)	1 Cards - Tape	In Archive
2. Final Report	1 Microfiche	To be Archived
72 WM COASTAL CIRCULATIONS (Csanady)		
1. Final Report	1 Microfiche	To be Archived
2. Spring Thermocline Behavior	1 Microfiche	In Archive
73 BC LAKE WATER CHARACTERISTICS (Pinsak)		
1. Edited Depth, Temperature, Chemical Composition Data	2 Magnetic Tapes	In Archive
74 TW SNOW OBSERVATION NETWORK (Sykes)		
2. Rain Gage Charts - 13 Locations	1 Microfilm	In Archive
3. Student Observation Forms	5000 Pages	Retained by P.I.
4. Replications of Ice Crystals	500 Slides	Retained by P.I.
5. Photos of Flakes, Crystal Types	30 Film	Retained by P.I.
6. Final Report I. Oswego Weather Radar Project 1972/1973	3 Microfiche	In Archive
7. Final Report II. Precipitation Gages Plus Snowfall	1 Microfiche	In Archive
8. Final Report III. Supplemental Study 1973/1974	1 Microfiche	In Archive

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
76 BC FAUNA LIST (Robertson)		
1. Final Report	1 Microfiche	To be Archived
77 WM PHYSICAL LAKE PROPERTIES (Pickett)		
1. Current, Temperature Analysis	1 Microfiche	To be Archived
2. Final Report	1 Microfiche	To be Archived
3. Mean Temperatures and Currents, July 1972	1 Microfiche	In Archive
78 BC CARBON CYCLE MODEL (Robertson)		
1. An Ecological Model for Lake Ontario	2 Microfiche	In Archive
2. Final Report - Carbon Budget	3 Microfiche	In Archive
100 MS PHYSICAL DATA COLLECTION SYSTEM (P.I. CEDDA)		
1. Basic Data - Engineering Counts	24 Magnetic Tapes	Temporary Archive
2. Provisional Meteor. & Limno. Data (6-Minute) - Tapes	17 Magnetic Tapes	In Archive
3. " " " - Data Listing	32 Microfilm	In Archive
4. " " " - Time Series Graphics	11 Microfilm	In Archive
5. Final Meteor. & Limno. Data (6-Minute) - Tapes	9 Magnetic Tapes	In Archive
6. " " " - Data Listing of 6-Minuts Obs. & Hourly Averages	65 Microfilm	In Archive
7. " " " - Time Series Graphics	11 Microfilm	In Archive
8. " " " - Hourly Average Tapes	5 Magnetic Tapes	In Archive
9. Station Event Logs and Histories	6 Microfilm	In Archive
10. System Documentation	3 Microfiche	In Archive
11. Calibration Data	7 Microfilm	In Archive
12. Radiation (Provisional) (Stored at NCC)	44 Magnetic Tapes	Not Archived
13. Manual Edited Data	3 Magnetic Tapes	Temporary Archive
14. Sensor Calibrations	1 Magnetic Tape	Temporary Archive
15. Translated Cassette Data	30 Magnetic Tapes	Temporary Archive
16. Rochester Control Center Backup Tapes	54 Magnetic Tapes	Temporary Archive
17. Pre-Provisional Time Series Plots	13 Microfilm	Temporary Archive
18. Meteorological Data - CDN and US Buoys, Hourly	1 Magnetic Tape	In Archive
19. Precipitation Sensor Evaluation	1 Microfiche	In Archive
20. Miscellaneous PDCS Logs and Folders	1000 Pages	Temporary Archive
101 MS US IFYGL SHIP SYSTEM - RESEARCHER (P.I. CEDDA)		
1. Raw Data-Analog Field Tapes (Stored at NCC)	129 Analog Mag Tapes	Not Archived
2. Raw Data-Digital Decom Tapes (Stored at NCC)	322 Magnetic Tapes	Not Archived
3. 1-Second Data - (1/10 Second Subsurface)	310 Magnetic Tapes	In Archive
4. "On-station" data, 6-Minute averages and total radiation; EBT decibar average subsurface data	27 Magnetic Tapes	In Archive
5. DAS Documentation, Calibration, Bridge Event Logs	4500 Pages	Temporary Archive
6. DAS Documentation, Logs, and Traces	7 Microfilm	Temporary Archive
7. Time Series Graphics - 6-Minute Averages	1 Microfilm	In Archive
8. Manual Observations - Raw	3000 Pages	Temporary Archive
9. Manual Observations - Edited	4 Magnetic Tapes	In Archive
10. Quality Control Strip Charts	300 Strip Charts	Temporary Archive
11. EBT-9-Point Digitized (Both Ships, 2 Formats)	2 Magnetic Tapes	In Archive

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
12. EBT-X, Y Traces	1 Microfilm	In Archive
13. Time Series Graphics, 1-Second Data	55 Microfilm	In Archive
14. EBT Graphics	1 Microfilm	In Archive
15. 1-Second Data Listing	290 Microfilm	Temporary Archive
16. RESEARCHER Dissolved Oxygen Traces	2 Microfilm	In Archive
17. Barograph Charts	1 Microfiche	In Archive
18. Processing Documentation	1 Microfiche	To be Archived
19. XBT Data	1 Microfilm	In Archive
20. XBT Data - Digitized at NODC	1 Magnetic Tape	In Archive
21. System Manuals	180 Pages	Temporary Archive
22. Navigation Plots and Graphics	300 Charts	Temporary Archive
23. D.A.S. Tapes	267 Magnetic Tapes	Temporary Archive
102 MS US IFYGL SHIP SYSTEM - ADVANCE II (P.I. CEDDA)		
1. Raw Data Analog Field Tapes (Stored at NCC)	105 Analog Tapes	Not Archived
2. Raw Data Digital Decom Tapes (Stored at NCC)	310 Magnetic Tapes	Not Archived
3. 1-Second Data - (1/10-Second Subsurface)	306 Magnetic Tapes	In Archive
4. "On-station" data. 6-Minute averages and total radiation; EBT decibar average subsurface data	27 Magnetic Tapes	In Archive
5. DAS Documentation, Calibration, Bridge Event Logs	3900 Pages	Temporary Archive
6. DAS Documentation, Logs, and Traces	7 Microfilm	Temporary Archive
7. Time Series Graphics - 6-Minute Averages	1 Microfilm	In Archive
8. Manual Observations - Raw	2100 Pages	Temporary Archive
9. Manual Observations - Edited	4 Magnetic Tapes	In Archive
10. Quality Control Strip Charts	300 Strip Charts	Temporary Archive
11. EBT-9-Point Digitized (Included with 101, line 11)		
12. EBT-X, Y Traces	1 Microfilm	In Archive
13. Time Series Graphics, 1-Second Data	52 Microfilm	In Archive
14. EBT Graphics	1 Microfilm	In Archive
15. 1-Second Data Listing	197 Microfilm	Temporary Archive
16. Processing Documentation (Same as Task 101, Line 18)	1 Microfiche	To be Archived
17. Navigation Plots	28 Charts	Temporary Archive
103 MS RAWINSONDE (P.I. CEDDA)		
1. Raw Rawinsonde Data-Field Data Tapes	267 Magnetic Tapes	Not Archived
2. Raw Rawinsonde Data-Copy of Data Tapes	235 Magnetic Tapes	Temporary Archive
3. Raw Data - Meteorological Parameters Strip Chart. (See Line 9)	3000 Strip Charts	Retained by P.I.
4. Raw Data-Time Series Plots	66 Microfilm	In Archive
5. Final Data-5-Second Averages, Meteorological Parameters	18 Magnetic Tapes	In Archive
6. Final Data-10-Mb. Increments	3 Magnetic Tapes	In Archive
7. Final Data-50-Mb. Increments	1 Magnetic Tape	In Archive
8. Adiabatic Charts and Listings	66 Microfilm	In Archive
9. Raw Data - Microfilm of Line 3.	24 Microfilm	For Security
10. Description of Archived Data	1 Microfiche	In Archive
11. Down Track Trace	18 Magnetic Tapes	Retained by P.I.
12. Final (5-Second, 10-Mb., 50-Mb)	66 Magnetic Tapes	For Security
13. Documentation and Basic Information	1 Microfilm	In Archive
14. Data Distribution Charts (Spliced to Line 13)	- Microfilm	In Archive
15. Unedited, Unpacked, Raw Data	66 Magnetic Tapes	Temporary Archive
106 MS RESEARCH FLIGHT FACILITY (RFF) (P.I. CEDDA)		
1. RFF Basic Meteorological System	32 Magnetic Tapes	In Archive

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
2. Color Nose Camera	18 16mm Film	In Archive
3. B/W Right Side Camera	8 35mm Film	In Archive
4. B/W Left Side Camera	8 35mm Film	In Archive
5. RFF Photo Panel Camera	9 35mm Film	In Archive
110 MS STORET DATA (P.I. EPA)		
1. January 1975 Readout - Fiche	33 Microfiche	Temporary Archive
2. January 1975 Readout - Film	2 Microfilm	Temporary Archive
3. Final Chemistry & Quality Data - Microfiche	17 Microfiche	In Archive
4. January 1975 Readout - Tape	8 Magnetic Tapes	Temporary Archive
5. Final Chemistry & Quality Data - Tape	5 Magnetic Tapes	In Archive
6. Final Chemistry & Quality Data - Inventories	1 Listing	Temporary Archive
7. Final Biological Data - Tape	1 Magnetic Tape	To be Archived
117 MS SATELLITE DATA (P.I. NOAA, NASA, AWS)		
1. ATS III Images, 10x10" (Approx. 3600)	11 Film Prints	Temporary Archive
2. DAPP - Air Force Meteorological Satellite	Film	Not Archived
3. NOAA-2 VHRR, 10x10"	118 Film Prints	Temporary Archive
4. NOAA-2 VHRR digital	Magnetic Tape	Not Archived
5. Scanning Radiometer (Visible and IR)	38 Film Prints	Temporary Archive
6. Scanning Radiometer	Magnetic Tape	Not Archived
7. ESSA-9 AVCS, 6x6" Prints	31 Film Prints	Temporary Archive
118 MS MISCELLANEOUS IFYGL REPORTS (P.I. IFYGL)		
1. Technical Plan	38 Microfiche	In Archive
2. Bulletin	36 Microfiche	In Archive
3. Technical Manual Series	7 Microfiche	In Archive
4. Scientific Series	4 Microfiche	To be Archived
5. Two Nations, One Lake	3 Microfiche	In Archive
6. Proceedings, IFYGL Symposium, AGU	3 Microfiche	In Archive
7. First Annual Report, EPA	6 Microfiche	In Archive
8. Objective Analysis - Surface Meteor. Data	1 Microfiche	In Archive
119 MS IFYGL INTERCOMPARISONS (Robertson)		
1. Intercomparison Data and Methods	4 Microfiche	To be Archived
2. Final Report	1 Microfiche	To be Archived
3. IFYGL Chemical Intercomparisons	1 Microfiche	In Archive
200 SD HOURLY SURFACE AVIATION (P.I. NCC/NOAA)		
1. Surface Weather Observations - Forms	Paper	In NCC Files
2. " " " - Digitized	1 Magnetic Tape	"
3. " " " - Film	Microfiche	"
205 SD SYNOPTIC OBSERVATIONS (P.I. NCC/NOAA)		
1. Original 3 and 6-Hourly Synoptic Obs.	Paper	In NCC Files
2. " " " " - Fiche	Microfiche	"
210 SD DAILY CO-OP OBSERVATIONS (P.I. NCC/NOAA)		
1. Record of Climatological Observations	Paper	In NCC Files
2. " " "	Magnetic Tape	"

Table 3.--Summary of data in U.S. IFYGL Archive: United States tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
215 SD CLIMATIC SUMMARIES (P.I. NCC/NOAA)		
1. Local Climatological Data	Paper	In NCC Files
2. Preliminary Local Climatological Data	Paper	"
3. Climatological Data	Paper	"
225 SD RADAR OBSERVATIONS (P.I. NCC/NOAA)		
1. Radar Log	Paper	In NCC Files
2. Radar Film	Microfilm	"
230 SD STATION HISTORY/INSTRUMENTATION (P.I. NCC/NOAA)		
1. NWS Station Description Forms	Paper	In NCC Files
235 SD SOLAR RADIATION (P.I. NCC/NOAA)		
1. Hourly/Daily Digitized Data	Magnetic Tape	In NCC Files
2. Hourly/Daily Forms	Paper	"
3. Hourly/Daily Instrument Charts	Charts	"
240 SD RECORDER CHARTS (P.I. NCC/NOAA)		
1. Gust Recorder	Paper	In NCC Files
2. Triple Register	Paper	"
3. Barograms	Paper	"
4. Rain Gage	Paper	"
5. Rain Gage	Magnetic Tape	"
245 SD ANALYZED MAPS/CHARTS (P.I. NCC/NOAA)		
1. National Meteorological Center Charts	Microfilm	In NCC Files
2. " " " "	Paper	"
261 SD LAKE DATA (P.I. NCC/NOAA)		
1. Monthly Bulletin of Lake Levels	18 Reports	Temporary Archive
2. Great Lakes Water Levels	10 Reports	Temporary Archive
280 SD OTHER (P.I. NCC/NOAA)		
1. Aerial Photographs of Rochester	Prints	Temporary Archive

Table 4.--Summary of data in U.S. IFYGL Archive: Canadian tasks

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
1 FS REMOTE SENSING (Thomson)		
1. Lake Dynamics Utilizing Sun-Glint	1 Microfiche	In Archive
2. High Altitude Remote Sensing	1 Microfiche	In Archive
3. Optical Properties of the Great Lakes	1 Microfiche	In Archive
5 AB DIRECT MEASUREMENT OF ENERGY FLUXES (Donelan)		
1. Niagara Bar Micromet Data - 10 Min.	1 Magnetic Tape	In Archive
2. 30-Minute Average Radiation	1 Microfilm	In Archive
3. Determination of Aero. Drag Coef.	1 Microfiche	In Archive
4. Generalized Profiles	1 Microfiche	In Archive
8 EB SHORE GAGING STATIONS (Robertson)		
1. Hourly Averaged Water Temperature	1 Cards-Tape	In Archive
2. Key Punch Card Documentation	1 Microfiche	In Archive
3. Documentation of System	1 Microfiche	To be Archived
11 TW MONTHLY WATER BALANCE - BASIN (Witherspoon)		
1. Hydrologic Model of the Basin	1 Microfiche	In Archive
2. Storage in the Water Balance	1 Microfiche	In Archive
12 TW MONTHLY WATER BALANCE OF LAKE ONTARIO (Witherspoon)		
7. An Estimate of Water Balance	1 Microfiche	In Archive
8. Preliminary Lake Ontario Water Balance	1 Microfiche	In Archive
9. General Water Balance	1 Microfiche	In Archive
13 TW GROUNDWATER FLOW INTO LAKE ONTARIO (Lennox)		
1. Groundwater Flow - Simcoe and Ontario	1 Microfiche	In Archive
2. Groundwater Inflow - Canadian Side	3 Microfiche	In Archive
14 TW HYDROLOGY OF LAKE ONTARIO (MacDonald)		
1. Tributary Data	2 Microfiche	In Archive
2. Daily Discharge	1 Cards-Tape	In Archive
15 AB SPACE SPECTRA IN FREE ATMOSPHERE (McBean)		
1. Mesoscale Low-Level Flight Data	1 Magnetic Tape	In Archive
2. Mesoscale Low-Level Flight Data	2 Microfiche	In Archive
16 ME AIRBORNE RADIATION THERMOMETER SVYS (Irbe)		
1. Airborne Radiation Thermometer Maps	2 Microfiche	In Archive
18 ME CLIMATOLOGICAL NETWORK (McCulloch)		
1. Monthly Record Canadian Met. Data	1 Report	In Archive
2. 1972 Ship Data - All Lakes	1 Magnetic Tape	In Archive
4. Hourly Weather Data	1 Magnetic Tape	In Archive
20 ME BEDFORD TOWER PROGRAM (McCulloch)		
1. Bedford Tower Met. Data	1 Magnetic Tape	To be Archived

Table 4.--Summary of data in U.S. IFYGL Archive: Canadian tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
21 ME CANADIAN SHORELINE NETWORK (McCulloch)		
1. Met. Data: Shoreline Stations	4 Magnetic Tapes	In Archive
22 ME SYNOPTIC STUDIES (Lalande)		
1. Synoptic Studies Analysis	1 Microfiche	To be Archived
23 ME PRECIPITATION IN CANADA (Pollock)		
1. Hourly Rainfall	1 Magnetic Tape	In Archive
2. Distrometer Data - Bowmanville	1 Magnetic Tape	In Archive
24 ME CLIMATOLOGICAL STUDIES (Phillips)		
1. IFYGL Weather Highlights	1 Microfiche	In Archive
2. Surface Weather Maps	3 Microfilm	In Archive
3. "Weather Data": Monthly Means & Deviations	3 Microfiche	In Archive
25 ME EVAPORATION BY MASS TRANSFER (Irbe)		
1. Monthly Estimates	1 Microfiche	In Archive
27 ME ISLAND PRECIPITATION NETWORK (McCulloch)		
1. Supplementary Precipitation Data	1 Microfiche	In Archive
28 AB MOMENTUM, HEAT, MOISTURE TRANSFER (McBean)		
1. Niagara Bar Micromet Data	1 Microfiche	In Archive
30 FS OPERATIONS - CCGS PORTE DAUPHINE (Rodgers)		
1. Digitized EBT Data (Included in USA 101, line 11)	1 Cards-Tape	In Archive
6. Shipboard Logs and Forms (Copy)	1 Microfilm	In Archive
7. Provisional Water Quality Listings	1 Printout	Not Archived
32 EB THERMAL BAR STUDY (Rodgers)		
1. Energy Budget Study	1 Microfiche	In Archive
34 WM CIRCULATION NEAR TORONTO (Rodgers)		
1. Tower: Current Spd. & Dir., Water Tmp.	1 Cards-Tape	To be Archived
38 TW GROUNDWATER CONTRIBUTION (Ostry)		
1. Observation Wells	1 Microfiche	In Archive
2. Snow Courses	1 Microfiche	To be Archived
3. Soil Moisture	1 Microfiche	In Archive
4. Overburden Well Yields	1 Microfiche	In Archive
5. Hydrology of Forty Mile Creek	1 Microfiche	In Archive
6. Bedrock Well Yields	1 Microfiche	In Archive
7. Groundwater Chemistry-40 Mile Creek	1 Microfiche	In Archive
8. Surficial Geology, N. Shore-New Castle	1 Microfiche	In Archive
9. Hydrogeology-Bowmanville, Newcastle	2 Microfiche	In Archive

Table 4.--Summary of data in U.S. IFYGL Archive: Canadian tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
40 WM COASTAL CHAIN STUDY (Csanady)		
1. Provisional Reports	6 Microfiche	In Archive
2. Final Report	1 Microfiche	In Archive
4. Daily Summary: Presquile	1 Punched Cards	Temporary Archive
5. Daily Summary: Oshawa	1 Punched Cards	Temporary Archive
6. Daily Summary: Presquile & Oshawa	1 Magnetic Tape	In Archive
7. Baroclinic Coastal Jets	1 Microfiche	In Archive
42 EB HEAT STORAGE OF LAKE ONTARIO (Boyce)		
1. Heat Content Survey Report #1	1 Microfiche	In Archive
2. Heat Content Survey Report #2	1 Microfiche	In Archive
3. Heat Content Survey Report #3	1 Microfiche	In Archive
4. Heat Content Survey Report #4	1 Microfiche	In Archive
5. Heat Content Survey Report #5	1 Microfiche	In Archive
6. Heat Content Survey Report #6	1 Microfiche	In Archive
7. Heat Content Survey Report #7	1 Microfiche	In Archive
8. Heat Content Survey Report #8	2 Microfiche	In Archive
9. Heat Content Survey Report #9	2 Microfiche	In Archive
10. Heat Content Survey Report #10	3 Microfiche	In Archive
11. Final Report	1 Microfiche	
12. River Flows and Temp. Inputs	1 Magnetic Tape	In Archive
43 WM INTERNAL WAVE MEASUREMENTS (Boyce)		
1. Transect Cross Section	1 Microfiche	In Archive
2. Fixed Temp. Profiler (FTP) Data	1 Not Known	To be Archived
3. Transect Tape (See Task 68)		
4. FTP Data File (See Task 42)		
44 AB ANALYSIS OF ENERGY FLUXES (Elder)		
2. Preliminary Estimates	1 Microfiche	In Archive
3. Preliminary Energy Budget	1 Microfiche	In Archive
4. Investigation of Wind Stress Field	1 Microfiche	In Archive
45 WM LAKE CURRENT MEASUREMENTS (Bennett)		
2. 10-Min Current, Temp. Data - Buoys (2 formats)	16 Magnetic Tapes	In Archive
3. Final Report	1 Microfiche	To be Archived
4. 10-Min Current, Temp. Listing	21 Microfilm	In Archive
46 TW ST. LAW.-NIAGARA RIVER MEASURING PROG. (Quast)		
1. Inflow Measurements	2 Microfiche	In Archive
49 TW SNOW STRATIGRAPHY & DISTRIBUTION (Adams)		
1. Peterborough Area: The Evolution of Snow Cover	1 Microfiche	In Archive
2. Areal Differentiation of Snow Cover	1 Microfiche	In Archive
7. Peterborough Area: Snow Data	1 Microfiche	In Archive
54 BC GROUNDWATER SUPPLY NEAR KINGSTON (Gorman)		
1. Geochemical Study of Deadman Bay	3 Microfiche	In Archive
64 ME BASIN EVAPOTRANSPIRATION (Ferguson)		
1. Monthly Evapotranspiration Estimates - Canadian Land Portion	1 Microfiche	In Archive

Table 4.--Summary of data in U.S. IFYGL Archive: Canadian tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
2. The Atmospheric Budgets Program of IFYGL	2 Microfiche	In Archive
65 ME EVAPORATION PAN NETWORKS (Phillips)		
1. Evaporation Pan Documentation	1 Microfiche	In Archive
66 ME ATMOSPHERIC WATER BALANCE (Ferguson)		
1. Atmospheric Water Balance	1 Microfiche	In Archive
2. A Spectral Investigation - Moisture Flux	1 Microfiche	In Archive
3. The Atmospheric Budgets Program	1 Microfiche	In Archive
67 ME SURFACE WATER TEMPERATURE (Webb)		
1. Mean Monthly Temperatures	1 Microfiche	In Archive
68 FS CCIW SUPPORTING RESOURCES (Sly)		
1. Shipboard Data - Star Format	2 Magnetic Tapes	In Archive
2. Description of Star System	1 Microfiche	In Archive
3. TSAR Format Documentation	1 Paper	In Archive
4. Shipboard - EBT Data	1 Magnetic Tape	In Archive
5. Star Monitor Layout	1 Paper	In Archive
6. Shipboard Logs and Forms	44 Microfilm	In Archive
7. Provisional Water Quality Listings	1 Printout	Not Archived
69 TW Pleistocene Mapping (Henderson)		
1. Maps and Charts	1 Microfiche	To be Archived
70 WM GROUND TRUTH FOR REMOTE SENSING (Falconer)		
1. Studies in the Lake Ontario Basin	1 Microfiche	In Archive
2. Flight Line Maps	1 Microfiche	In Archive
3. Photo-Optical Contrast Stretching	1 Microfiche	In Archive
71 EB CANADIAN RADIATION NETWORK (McCulloch)		
1. AES Radiation Data - See Task 80	-	-
3. Instrument Location Charts	1 Microfiche	In Archive
72 EB FLOATING ICE RESEARCH (Ramseier)		
1. Navigation Season Extension Studies	3 Microfiche	In Archive
2. Studies, Extension of Winter Nav.	1 Microfiche	In Archive
73 EB TERRESTRIAL HEAT FLOW (Judge)		
1. Analysis of Heat Data	1 Microfiche	In Archive
2. Mud Temperature Gradient	1 Microfiche	To be Archived
3. Thermal Conductivity of Lake Ontario	1 Microfiche	To be Archived
74 TW WATER LEVEL NETWORK (Dohler)		
7. Format Hrly. Header & Monthly Cards	1 Paper	In Archive
8. Water Levels, hourly. Port Weller, Toronto, Burlington, Cobourg, Point Petre and Kingston	1 Magnetic Tape	In Archive

Table 4.--Summary of data in U.S. IFYGL Archive: Canadian tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
75 AB WIND & TEMPERATURE FLUCTUATIONS (Smith)		
1. Niagara Bar Preliminary Data	1 Microfiche	In Archive
2. Niagara Bar Final Data	1 Microfiche	In Archive
3. Report - Eddy Flux Measurements	1 Microfiche	In Archive
76 WM SURFACE WAVE STUDIES (Holland)		
1. Final Report - Wave Climate Study	1 Microfiche	Not Known
2. Wave Climate Data - Cobourg	1 Magnetic Tape	In Archive
4. Wave Climate Data - Main Duck Island	1 Magnetic Tape	In Archive
5. Equiv. Wave Hts. Vs. Period, 3 Stns	2 Microfiche	In Archive
8. Wave Climate Data - Toronto	1 Magnetic Tape	In Archive
10. Format for Wave Climate Study	1 Microfiche	In Archive
79 FS BATHYMETRIC SURVEYS - LAKE ONTARIO (McCulloch)		
1. Lake Ontario Bathymetric Data	1 Magnetic Tape	In Archive
80 EB RADIATION BALANCE PROGRAM (Davies)		
1. Radiation Data	1 Cards-Tape	Not Known
2. Radiation Data	1 Printout	Not Archived
3. Final Report, Canadian Radiation	2 Microfiche	In Archive
81 BC MATERIAL BALANCE LAKE ONTARIO (Salbach)		
1. Water Quality Info - Preliminary	2 Microfiche	In Archive
2. Water Quality Data - Trib Streams	2 Microfiche	In Archive
3. Water Quality Data - Ontario	1 Publication	Temporary Archive
82 BC ZOOPLANKTON MIGRATION (Roff)		
1. Energetics of Vert. Migration	2 Microfiche	In Archive
83 BC COOP STUDIES OF FISH STOCKS (Christie)		
1. Times, Locations of Trawl Drags	1 Microfiche	In Archive
2. Effects on the Salmonid Community	1 Microfiche	In Archive
3. Changes in Fish Species Composition	2 Microfiche	In Archive
84 BC CLADOPHORA GROWTH (Owen)		
1. Location and Extent of Cladophora	1 Microfiche	To be Archived
85 BC NUTRIENT CYCLES, LAKE ONTARIO (Fraser)		
1. Phosphorus & Nitrogen Transects	1 Microfiche	In Archive
86 BC SURFACE PLANKTON SURVEY (Nicholson)		
1. Pigment Analysis: Chlorophyll a	3 Microfiche	In Archive
87 EB HEAT FLOW TO LAKE ONTARIO (Boyce)		
1. (Included in Task 42 EB)		
89 WM TURBULENT DIFFUSION STUDIES (Murthy)		
1. Large Scale Diffusion Studies	2 Microfiche	In Archive
2. Nearshore Diffusion Studies	1 Microfiche	In Archive

Table 4.--Summary of data in U.S. IFYGL Archive: Canadian tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
3. Lagrangian & Current Measurements	1 Microfiche	In Archive
4. Diffusion in Thermocline and Hypolimnion Regions	1 Microfiche	In Archive
5. Dispersion of Floatables	1 Microfiche	In Archive
6. Observations of Lateral Shear	1 Microfiche	In Archive
7. Helmholtz Resonance in Harbors	1 Microfiche	In Archive
94 FS DATA RETRANSMISSION BY SATELLITES (MacPhail)		
1. Data Retransmission	1 Microfiche	In Archive
95 WM HYDRODYNAMICAL MODELLING (Simons)		
6. First Report: Model Study of Agnes	2 Microfiche	In Archive
7. Model Study of Betty Storm	2 Microfiche	In Archive
8. Development of Numerical Models	1 Microfiche	In Archive
9. Development of Numerical Models Part 2	1 Microfiche	In Archive
10. Three-Dimensional Models	1 Microfiche	In Archive
11. Observations & Computer Current - Hurricane Agnes	1 Microfiche	In Archive
12. Hydrodynamical Modelling Studies	1 Microfiche	In Archive
13. Verification of Numerical Models Part 1	1 Microfiche	In Archive
97 AB METEOROLOGICAL BUOY MEASUREMENTS (Elder)		
1. 10-Minute Observational Data and 1 Hour Average Data	6 Magnetic Tape	In Archive
2. Preliminary Invest. - Wind Stress Field	1 Microfiche	In Archive
3. Field Report	1 Microfiche	In Archive
4. Summary of Meteorological Buoy and Manual Data	2 Microfiche	In Archive
5. A Meteorological Buoy System for Great Lakes Studies	1 Microfiche	In Archive
6. Listings	11 Microfilm	In Archive
98 BC LAKE ONTARIO CROSS-SECTION STUDY (Munawar)		
2. Abundance of Diatoms, SW Nearshore	1 Microfiche	In Archive
101 BC LAKE ONTARIO PRIMARY PRODUCTION STUDY (Munawar)		
1. Measurement and Prediction	1 Microfiche	In Archive
2. Primary Production at an Inshore and Offshore Station	1 Microfiche	In Archive
3. Phytoplankton Biomass, Species Composition and Primary Production	1 Microfiche	In Archive
102 BC DIEL PIGMENT VARIATION (Glooschenko)		
1. Diel Chlorophyll a Variations	1 Microfiche	In Archive
103 BC PESTICIDE CONCENTRATION - BIRD EGG (Gilbertson)		
1. Seasonal Changes in Terns Eggs near Hamilton	1 Microfiche	In Archive
104 BC RAIN QUALITY MONITORING (Shiomi)		
1. Composition of Precipitation	1 Microfiche	To be Archived

Table 4.--Summary of data in U.S. IFYGL Archive: Canadian tasks (cont'd)

TASK - PANEL - TASK NAME - (PRINCIPAL INVESTIGATOR)	QUANTITY - MEDIA	STATUS
107 AB AIR POLLUTION SINKS (Whelpdale)		
1. Sulphate Deposition by Precipitation	1 Microfiche	In Archive
108 TW LAKE LEVEL TRANSFER		
1. Water Level Data for Point Petre (Data from Task 74)	1 Listing	Not Archived
109 WM UPWELLING STUDY (Rodgers)		
1. Water Temperature (EBT): See Task 30		
110 WM HYDROLOGICAL INTAKE STUDY (Arajs)		
1. Water Current and Temperature Chub Point, Bowmanville, Weoleyville, Pickering and Lennox	1 Cards-Tape	In Archive
2. Nearshore Currents and Temperatures Pickering and Cobourg	1 Microfiche	In Archive
111 WM LAKEVIEW DISPERSION STUDY (Palmer)		
1. Current Meter Data - Lakeview	1 Magnetic Tape	In Archive
2. Current Meter Data - Lorne Park	1 Magnetic Tape	In Archive
115 WM WAVE CLIMATOLOGY (Cho)		
1. (Manual Records at CCIW)	1 Papers	Not Archived
116 TW AIRBORNE GAMMA-RAY SNOW SURVEY (Loijens)		
1. Snow-Water Equivalent	2 Microfiche	In Archive
2. Experimental Snow Survey	1 Microfiche	In Archive
3. Comparison of Water Equivalent	1 Microfiche	In Archive
117 ME APT PHOTOGRAPHS (McCulloch)		
1. ESSA-8 APT Photographs	1 Microfilm	In Archive
118 FS PUBLICATIONS (Byron)		
1. Plan of Study for IFYGL	1 Microfiche	In Archive
2. Objective Analysis - Surface Pressure	1 Microfiche	In Archive
3. Numerical Models of Airflow	2 Microfiche	In Archive
4. 1971 Buoy Intercomparison	1 Microfiche	In Archive
5. Canadian Projects & Supplements 1-4	7 Microfiche	In Archive
6. Canadian Data Submissions 7/31/74	2 Microfiche	In Archive
7. Intercomparison - Research Aircraft	1 Microfiche	In Archive
8. Hydrometeorological Studies	1 Microfiche	In Archive
9. The IFYGL Field Year	1 Microfiche	In Archive
10. Short Period Tides	1 Microfiche	In Archive
11. Final Canadian Data and Information Catalog	5 Microfiche	In Archive

CANADA

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NEARSHORE DIFFUSION STUDIES
(IFYGL Project 89WM)

C.R. Murthy and K.C. Miners

1. Introduction

Turbulent diffusion of a marked fluid in large natural bodies of water such as the oceans and the Great Lakes is a very complex phenomenon. It is not easily accessible to theoretical treatment except in very idealized conditions, i.e., steady, uniform currents with a homogeneous field of turbulence. Although considerable progress has been made by theoretical studies under somewhat ideal conditions, an understanding of the various manifestations of the turbulent diffusion phenomenon in natural bodies of water is still largely dependent on conducting large scale field diffusion experiments. With this basic objective in mind, a series of continuous dye plume diffusion experiments was conducted in coastal currents off Oshawa, Lake Ontario as part of an integrated study of turbulent diffusion processes during the International Field Year for the Great Lakes (IFYGL). This report is a documentation of the experimental observation of a series of nearshore diffusion experiments carried out during IFYGL.

2. Experimental Equipment

The tracer release and sampling systems described here evolved over a four year period of combined scientific and equipment development studies. Major equipment and instruments were selected, not only for suitability, but for reliability over extended periods of operation under harsh conditions. Wherever possible, interfacing was done with the off-the-shelf materials on the premise that savings in down time for repairs and modifications outweighed the higher quality and better appearance afforded by specialized hardware.

Source

A 3.0 by 8.5 metre catamaran served as a surface platform for the injection system with ample reserve space for storage of service equipment and spare parts. Equipment was protected by a 2.1 x 3.0 metre deckhouse.

110 V. 60 Hz. power from a 3 KVA Onan air-cooled diesel generating plant supplied the injection system with plenty to spare for lighting and auxiliary equipment.

The pumping system was designed for uninterrupted, accurate delivery of dye solution for periods of up to several days. Such long studies were not a primary goal of this series; however, continuous releases of tracer for over fifty hours were attained on two occasions. The tracer delivered through the main feeder hose was the combined output of two subsystems: a high pressure, low volume injecting system which metered the dye from the tank; and a low pressure, high volume water pumping system (Figure 1). The former employed one of two American Meter Control, Series 50 diaphragm pumps

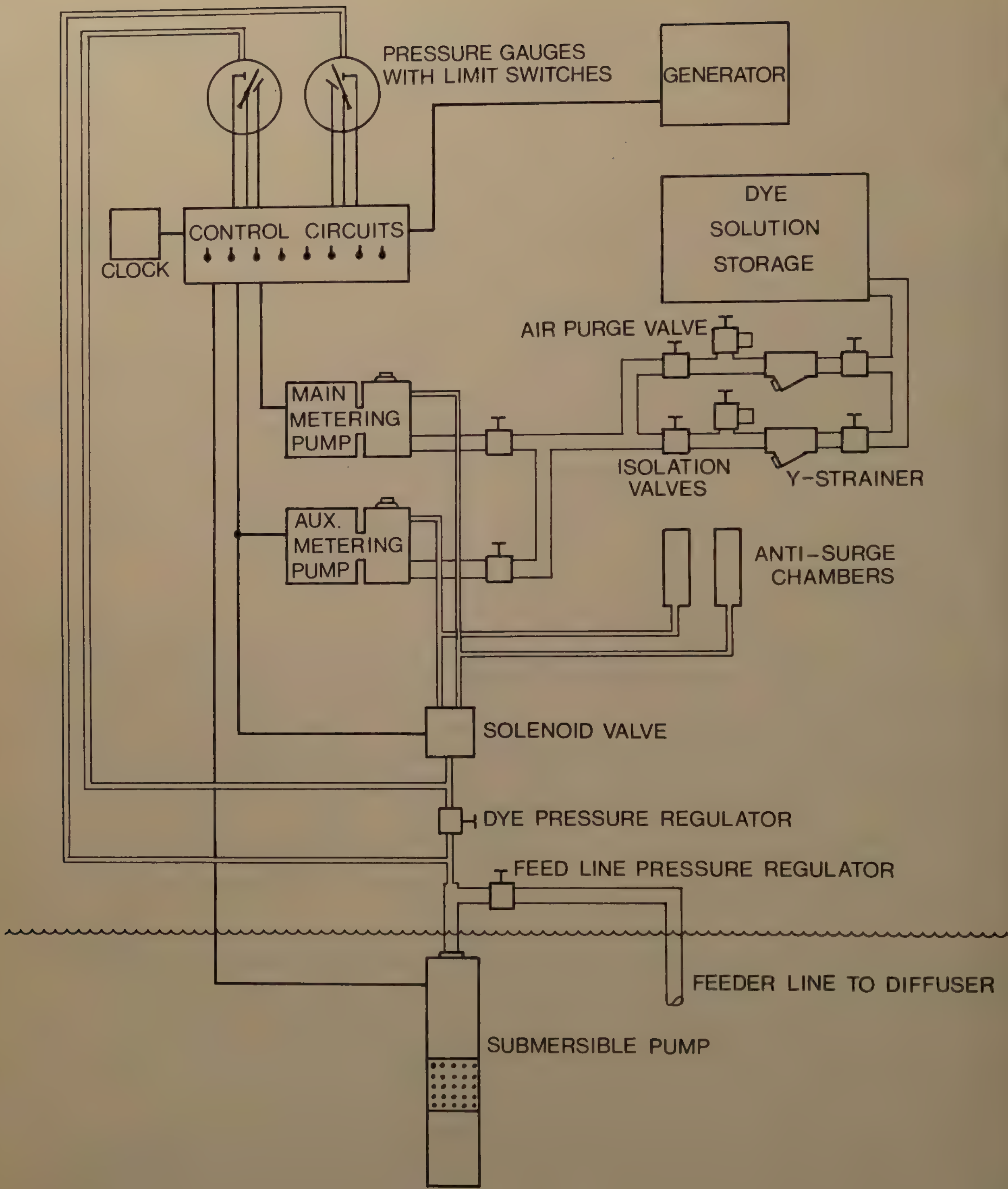

Figure 1.--Injection system.

capable of accurate delivery of fluid over a precisely adjustable range of 0 to 64 litres per hour, to pump dye into the feed line. The latter system employed a 1/4 HP Jaccuzzi submersible well pump mounted about 0.5 metres below the surface, between the hulls of the platform, to supply water to the feed line.

A control circuit consisting of four DPDT relays a timed relay, and two pressure gauges equipped with adjustable high and low pressure limit switches, continually monitored the injection system's operation. Normally, the pressure of the metering pump outlet was maintained above feedline pressure by a needle valve. Failure of the metering pump would allow the pressure to fall to feedline pressure which would close the low pressure limit switch on the gauge monitoring that part of the system. This, in turn, would result in shut-down of the main pump and simultaneous start-up of the auxiliary pump. A three-way solenoid valve on line with the auxiliary pump opened to flow from the auxiliary and closed to flow in the main pump outlet, thereby preventing back-flow into the main pump if the failure were due to faulty valves or ruptured diaphragm. Low pressure conditions also activated the timed relay. If auxiliary start-up failed to restore operating pressure within fifteen seconds, the entire system would shut down. High pressure conditions immediately shut down the entire system on the assumption that switching to auxiliary would not alleviate the fault.

Indicator lights on the control panel remained lit upon failure to show what component had failed and whether pressure had gone too high or too low, and a twenty-four hour digital clock stopped with the system to indicate time of failure. These features aided trouble-shooting immensely.

System failures nearly always originated in the dye metering network. The metering pumps were very reliable but at such low flow rates a very small amount of sludge or gas would halt flow. These contaminants were minimized by the installation of fine strainers and vapour traps on the pump inlets. In addition, the stock 40% dye solution was further diluted in the tank by adding methanol in the ratio of 1 part to 2 parts dye. This served to redissolve most sludge present and also allowed a higher low rate to be used without net increase in dye concentration. The solution in the tank had a concentration of 27% rhodamine by weight and was pumped at a rate of 12 litres per hour. When mixed with water in the feedline, the concentration dropped to 2.35×10^{-3} with a total flow rate of 1370 litres per hour.

The anchor system and line source injector array are illustrated in Figure 2. The line source was designed to simulate -- on a small scale -- the multi-port waste effluents used on many municipal and industrial installations.

Whereas an actual system would be fixed, the simulator was made to rotate such that the tail fin would keep the bar perpendicular to the flow with the nozzles pointing downstream. This was done so the plume width at source would not be a function of the diffuser's attitude to the flow. Dye

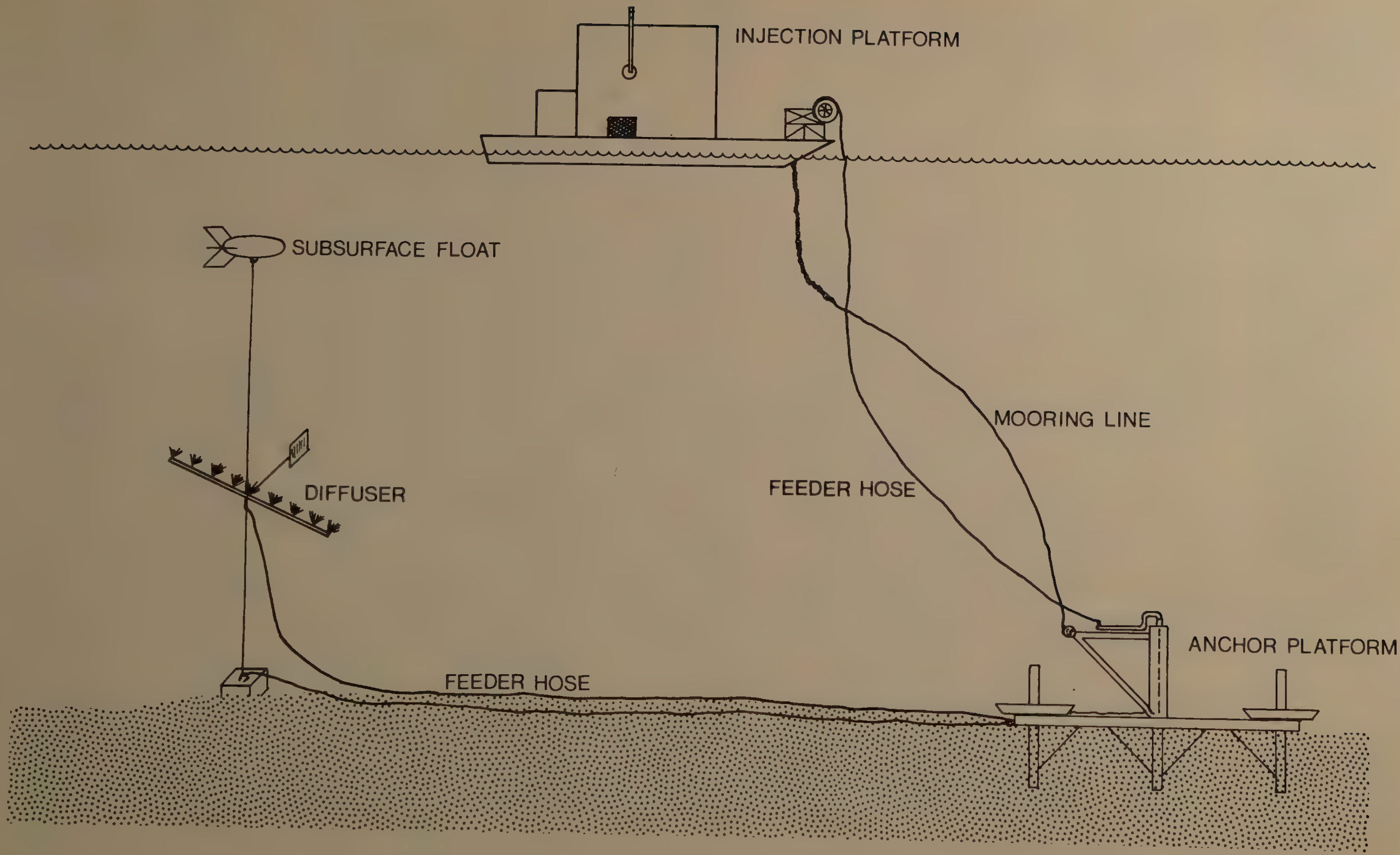

Figure 2.--Dye release system.

solution entered the hollow centre-link of the diffuser bar through a free rotating, '0'-ring sealed, coupling. It then flowed out into the arms of the device which were constructed of 5 metre lengths of 38 millimeter stainless steel pipe. From here, the dye entered the water through the ten 1.6 mm diameter nozzles mounted at 1 metre intervals along the length of the bar.

The solution to the problem of mooring the source in the open lake for several months would have been fairly simple had it not been necessary for the feeder hose to run from the platform to the diffuser. Exposure to bad weather ruled out anchoring the platform from four corners which would have simplified the feeder hose installation; and mooring on a single line with sufficient scope to allow the platform to ride out heavy seas head-on would have provided endless opportunity for the hose to foul on the anchor, boulders on the bottom, etc., if it were simply laid out from the deck to the diffuser mooring. Many of the difficulties were eliminated with a unique anchor consisting of a 2 metre square steel platform with a 17 cm diameter steel leg extending above and below the platform at each corner and in the centre. A rugged triangular frame was secured to the taller centre leg with two steel rings which allowed the frame to rotate about the leg. The mooring line from the injection platform was attached to the outer corner of the frame while the feeder hose coupled to a pipe running along the top of the frame to a rotating union in the centre of the top cap on the leg. From the bottom fitting of the union, a hose ran down the inside of the leg and out to one corner of the anchor. From here a final length of hose ran across the lake bottom and up to the diffuser some 60 metres away -- well outside the scope of the moored platform.

Anchor line lengths at least five times the water depth are desirable; however, the feeder hose and anchor line for this application were only about twice the water depth to reduce the opportunities for fouling. Additional measures were taken to keep the lines off the bottom, and below the platform, even when maximum slack developed with the platform drifting over the anchor -- a situation which was observed with surprising frequency. The anchor line was made up of 15 metres of 9.5 millimetre chain at the platform end and the remaining 25 metres of 22 millimetre floating polypropylene rope. The feeder hose was 13 millimetre I.D. nylon reinforced vinyl garden hose, buoyed up over the lower 15 metres with styrofoam rings. At the platform, the hose entered the water from a reel mounted on the starboard rail near the bow. Several metres of extra hose were wound on the reel which was stopped off with light line such that excessive strain on the hose would part the line and free more slack hose. In spite of all precautions, the lines did foul a few times during four months of service; however, damage and down time attributable to this cause were minimal.

Sampling System

Throughout these experiments, the survey launch 'Aqua' served as the principal dye sampling vessel. The 'Le Moyne' was fitted out with identical sampling boom and instrumentation and logged many hours of sampling in addition to collecting current and temperature data.

Each vessel was equipped to sample from three depths simultaneously. The continuously pumped sample from each depth passed through a Turner Model III fluorometer equipped with high volume flow cell. The fluorometer output -- a linear function of concentration -- was recorded on a Hewlett-Packard Model 680 analog recorder.

Little Giant Model 4E-34NRT submersible pumps were mounted at 1, 3, and 6 metres on a 6 metre long, foil-shaped, extruded aluminum sailboat mast. During sampling, this boom hung vertically from a bracket on the port gunwhale of the launch. A cable running from a handwinch mounted near the bow to the lower end of the boom served as a brace and a means of raising and lowering the boom. When not in use, the boom was drawn up horizontal and pulled inboard.

Neoprene covered cables supplying 110 V.A.C. power for the pumps and nylon reinforced vinyl garden hose to carry the samples passed through the hollow core of the boom. The upper ends of the hoses led into the cabin and attached to the instruments. A second hose on each instrument exhausted sample waste over the side.

The system on the Aqua (Figure 3) was arranged such that the portion of the sample path from the gunwhale near the top of the boom to an instrument cabinet inside the cabin consisted of permanently mounted copper pipes. The instruments were mounted on roll-out shelves in the cabinet. Each compartment had its own door making it possible to protect the instruments from direct sunlight which might have entered the detector compartment of the instruments.

The instrument cabinet which was built to accommodate up to six instrument systems had a separate rack to hold HP680 recorders at a convenient height to monitor their operation and enter handwritten information. A switch panel below the recorders provided control over instrument power in addition to individual and ganged event marker and pen-lift control. To further reduce the maze of wires and hoses, a collector manifold for sample waste was installed in the back of the cabinet reducing the effluent to a single pipe. In order to prevent overheating of the confined instruments two fans were installed in the cabinet to maintain airflow.

3. Experimental Procedure

An adequate quantitative description of the dispersal of a dye plume generated in the wake of a point source requires that concentration profiles be obtained along several cross-sections of the plume. Profiles obtained simultaneously from several depths provide the basis for a reasonable reconstruction of the plume in three dimensions. Moreover, the acquisition of several sets of profiles at each cross-section facilitates statistical treatment of the data, and the creation of a 'mean' plume free of the erratic features (owing to random concentration anomalies) prevalent in the 'instantaneous' picture derived from single profiles. Since these erratic concentration levels are smoothed out to a great extent as the distance from the source increases, the mean concentration distribution can be determined

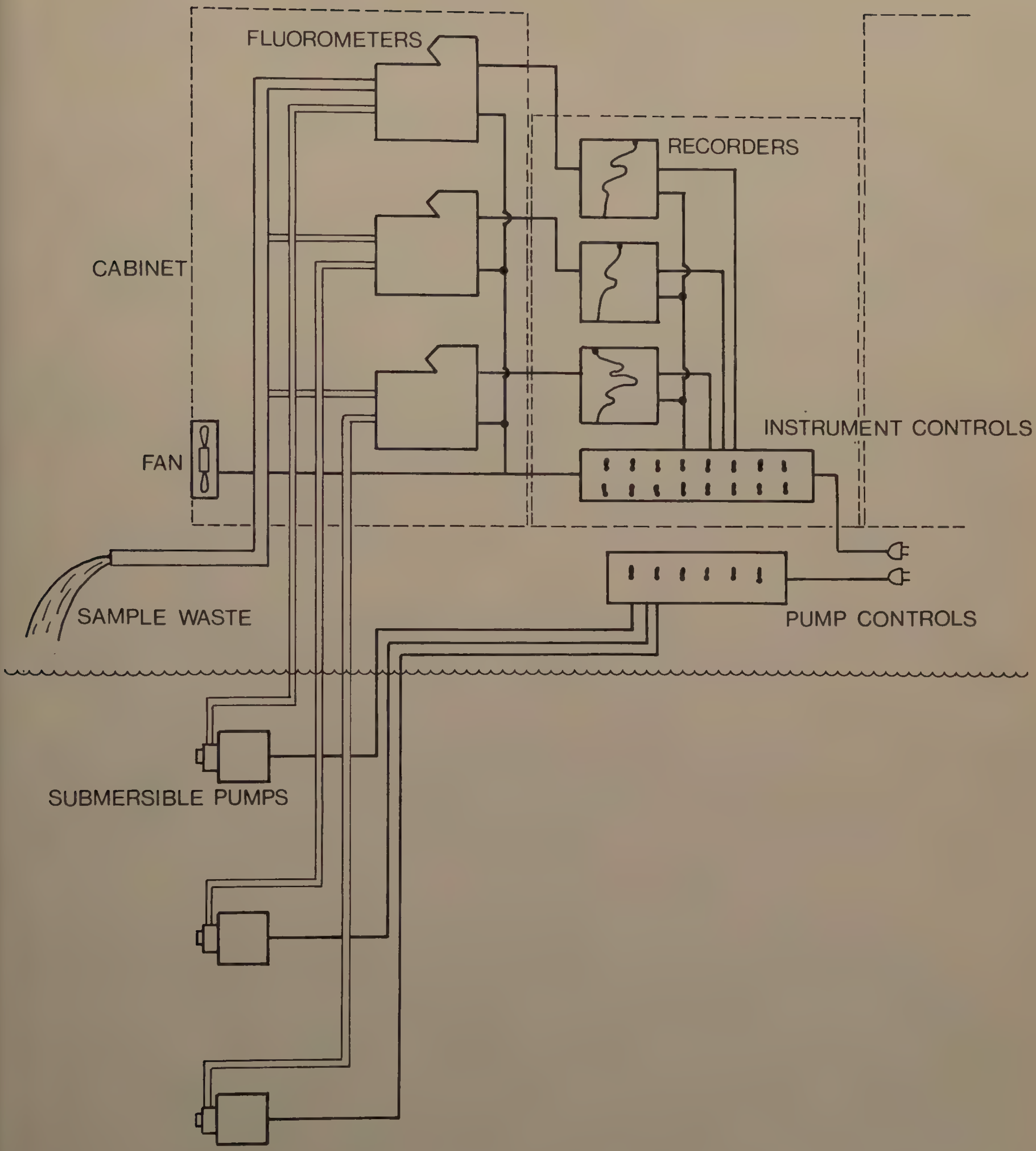

Figure 3.--Sampling system.

from fewer profiles per cross-section. This is fortunate from a logistic standpoint: one run across a section about half a kilometer from the source takes less than two minutes, while at about two kilometers, the time per run increases to over ten minutes.

In order to obtain adequate data at the Oshawa experimental site, it was necessary to spend about ten hours on the lake without equipment failure or deterioration of environmental conditions. On good prospective days, the Aqua proceeded to the source to start dye flowing while the Le Moyne anchored nearby to track drogues and take temperature profiles. Additional current data was obtained with a Q-15 current meter coupled to a Hewlett-Packard two pen recorder. The current meter was deployed from the source platform, or from the Le Moyne, either at a fixed depth, or cycled up and down in one metre steps, recording for ten minutes at each level.

While the dye plume developed, instruments were warmed up; the sampling boom was lowered; and zero checks were made on the fluorometers and recorders. Once the plume was developed sufficiently, the first cross-section was established by traversing the plume at increasing distances from the source until a point was found where the peak concentration fell within the least sensitive range of the instrument. This location was marked by anchoring a flag buoy on each side of the plume to aid navigation for the sampling transects to follow.

Launch speed of from 2.5 to 3.0 metres per second (5 to 6 knots) was maintained constant throughout sampling. The actual time to pass from one flag to the other was determined with a stopwatch, and recorded for each run.

Subsequent cross-sections were established and sampled in a similar manner at intervals of several hundred metres along the plume. Trial passes at each new cross-section were used to determine optimum combinations of fifty percent, and ten percent neutral density filters on the detector side of the fluorometers' light-path in order to attain maximum height on the recorder paper without clipping the peaks. The aperture marked 30X was used on all instruments throughout the experiments.

The problem of logging supplementary information on moving recorder charts was solved by keeping a separate data log with information referenced by a number. At appropriate times, simultaneous event marks were made on all recorder charts and a consecutive number written beside them. The number was also written in the log book with the pertinent information and time beside it. The preprinted log sheets had labelled columns for routine data plus space for remarks and special information. Thus, the start time, elapsed time, course, and various instrument settings were recorded in an orderly manner for each profile. Aside from tremendous saving in time during data reduction, the incidence of illegible and omitted data dropped to near zero.

Frequently, the plume meandered outside the marker flags during sampling. In this situation, the transect was made between the flags as

usual to provide a real reference but course was maintained beyond the flag until instrument readings fell to zero. At this point, an additional reference mark was made on the charts; the boat was turned and realigned for the return pass; and another reference mark was made to signify that conditions were acceptable for the profile to follow.

Accurate positioning of the flags was essential to analysis of the data. Relative speed and simplicity led to the use of the IFYGL Decca Navigator System for this task in spite of the greater potential for error over other methods. Although the predicted error band was unacceptably large in the Oshawa area, the drift in the signal pattern under reasonable atmospheric conditions was slow enough to facilitate good positioning of the source and markers, relative to one another, by taking all readings in as short a time as possible. For this reason, all fixes were taken together at the end of an experiment; or, if conditions were unfavourable, markers were left in place until favourable conditions resumed. Unfortunately, such delay sometimes resulted in markers dragging anchor or breaking free. Cross-checks with known launch speed and crossing time indicated that marker positions were at least reasonable in most cases.

4. Data Analysis and Summary

When fluorescent dye is released continuously into turbulent coastal currents, the subsequent transport and diffusion may be studied either in a frame of reference moving with the centre of gravity of the plume or in a frame of reference fixed to the stationary source. Conventionally, the former is referred to as "relative" diffusion and the latter as "absolute" diffusion. The inter-link between the two concepts is explained by the random movements of the centre of gravity of the diffusing plume usually referred to as the "meandering". Following Gifford (1959, 1960) and Csanady (1963), one may regard "absolute" diffusion (that which is measured at a fixed point) as a superposition of the two component processes of "relative" diffusion, i.e., diffusion relative to the centre of gravity of the plume and "meandering" or bodily displacements of the diffusing plume parcels.

In the past, experimental data from continuous dye plumes in coastal currents have been used to study "relative" diffusion, neglecting the random movements of the centre of gravity. In reality, however, "meandering" appears to be a more efficient agency than "relative" diffusion from the practical point of view of dispersing effluents over larger volume of the water body. For continuous release of effluents, intuititvely, one could argue that the "meandering" effects are relatively strong closer to the effluent source, since the slender plume is subject to random bodily displacements due to large scale horizontal eddies. Csanady (1963) and Kenney (1966) have studied the "meandering" problem based on extensive point source dye plume diffusion experiments in coastal currents.

In the present analysis, particular attention is given to delineate the two component processes of "relative" diffusion and meandering by taking a large number of crossings at a constant depth and a fixed distance from

the dye source and by accurate position fixing such that concentration measurements can be made in absolute coordinates reasonably accurately.

All experiments were conducted in the vicinity of the IFYGL Oshawa coastal chain to take advantage of the general environmental data. The results of preliminary analysis of the data from this series of experiments, conducted under a variety of environmental conditions, are summarized in a separate report of limited circulation.

Typically, sampling was done at 1, 3, and 6 metre depths, and at distances varying from 200 m to 2 km from the dye source. Representative diffusion data is presented as "relative" and "absolute" mean concentration profiles, while environmental data (an EBT Profile and current holograph) are summarized separately.

5. Properties of Mean Concentration Profiles

The statistical properties of "relative" mean concentration distributions in the wake of continuous dye plumes in coastal currents are known to a fair degree of accuracy both from theoretical (Okubo and Karweit, 1969) and experimental (Murthy and Csanady, 1970; Bowden et al., 1974; and Sullivan, 1973) studies. A large number of cross-plume instantaneous concentration profiles obtained at a constant depth and at a fixed distance from the source were used to construct "relative" mean concentration profiles. In order to remove the effects of meandering, the individual concentration profiles were overlapped such that their centres of gravity coincide and averaging was carried out at fixed distances from the centre of gravity. These "relative" mean concentration profiles have been approximated to be Gaussian with some theoretical justification. However, quite often the cross-plume "relative" mean concentration distributions constructed from repeated observations exhibit skewness with depth and with distance from the source, presumably due to horizontal and vertical current shear. Gaussian approximation is, therefore, an exception rather than a rule in steady and uniform currents.

The foregoing discussion has been concerned with the relative diffusion of the dye plume about its centre of gravity, neglecting the movements of the centre of gravity. In reality, "meandering" is a dominant diffusion mechanism caused by turbulent eddies typically comparable to, or larger than, the plume itself. The net effect of meandering is to smear the mean concentration profile. In previous experiments, the movements of the sampling launch were not tracked with sufficient accuracy to determine absolute positions. In this series of experiments, an experiment was attempted in which a large number of crossings were made at a constant distance downstream from the source and the necessary accuracy in position was attained to be able to locate concentration measurements in absolute coordinates. With this example, we will attempt to delineate the differences in "relative" and "absolute" mean concentration distributions constructed from a large number of cross-plume instantaneous concentration profiles.

Figures 4 and 5 show the "absolute" and "relative" distributions, respectively, from 48 crossings at 3 depth and at 375 m distance from the dye source. These figures show individual concentration profiles, plus the mean concentration profile, plotted against cross-plume distance, y, perpendicular to the mean axis of the plume. It is of interest to note the differences in the spread (as measured by some factor of standard deviation) and centre line concentration of the two profiles. In "relative" diffusion, the size of the "patch" or "plume" sets a clear limit to the eddy size and the effect of sampling time on the growth of variance (or its square root, the standard deviation) is not particularly a problem. However, the sampling time has considerable effect on the growth of the variance of meandering. Based on dye plume diffusion experiments in coastal currents off Douglas Point, Lake Huron, Csanady (1963) has shown that the variance of meandering at a fixed distance of 750 m from dye source increases with sampling time before attaining a constant value in about 3 hrs. or so. The above arguments lead to the conclusion that the sampling-time effects are particularly important in "absolute" diffusion (when observing concentration history at fixed points) where the combined effects of "relative" diffusion as well as meandering are responsible for concentrations observed at fixed points. To delineate the differences, extensive sampling was carried out at a fixed distance relatively close to the source. Figures 4 and 5 also show the mean concentration profiles (corresponding to a total sampling time of about 5 hrs.) in the two frames of reference. It is interesting to note that the effect of meandering is to smear the mean concentration profile. As a consequence, the spread of the plume in absolute diffusion is greater than in the case of relative diffusion. The centre-line concentration is correspondingly less in relative diffusion than in the absolute diffusion. From the practical view-point of dispersing effluents over a larger volume, "meandering" appears to be a more efficient agency than relative diffusion caused by small scale eddies.

Discussion

The data presented in this report shows the general variability of diffusion patterns in coastal currents and illustrates the many complex aspects of turbulent diffusion phenomenon particularly in regard to day-to-day variability of turbulence structure in coastal currents. The two important physical mechanisms namely "relative" diffusion mainly caused by small scale eddies and "meandering" diffusion caused by much larger scale eddies are identified. In reality, it is difficult to separate out the contributions of these two effects, while interpreting apparent transverse diffusion characteristics. From the point of view of predicting concentration levels at fixed points, both effects are important, although "meandering" appears to be a much more efficient mechanism.

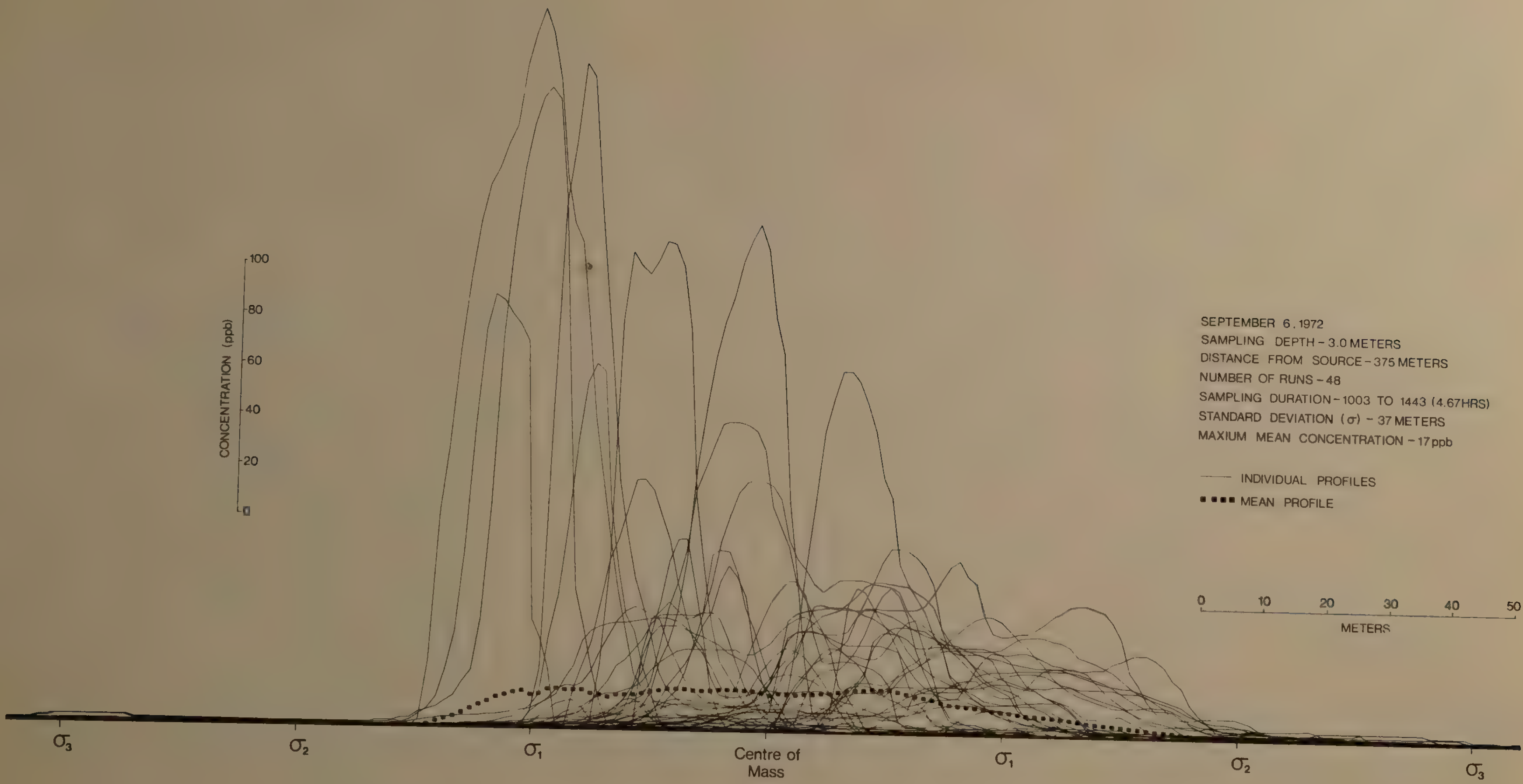

Figure 4.--Crossplume concentration distribution - absolute.

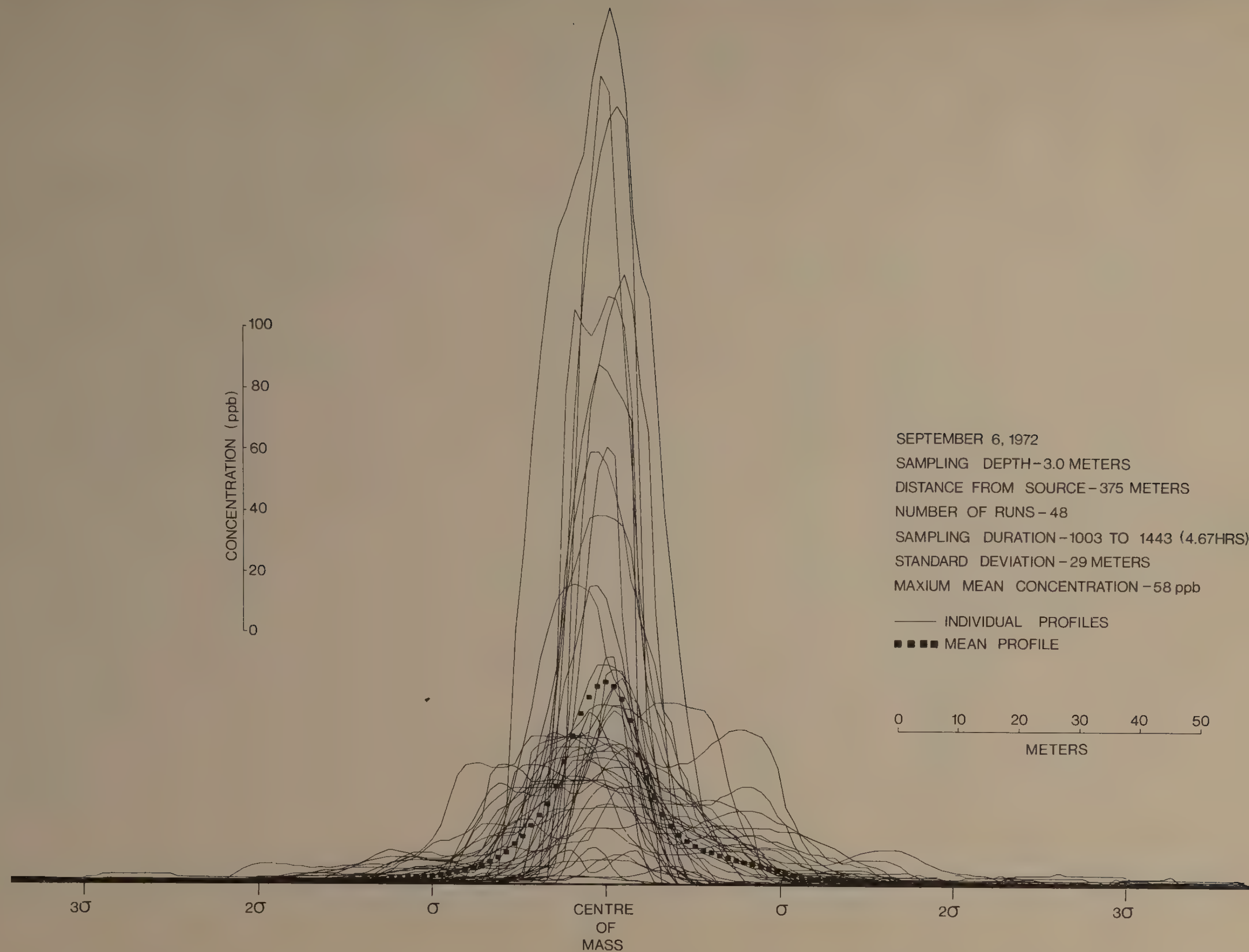

Figure 5.--Crossplume concentration distribution - relative.

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CANADIAN PROJECT REPORTS

Notes:

1. Projects are numbered consecutively.
2. The letters following the number indicate which panel has prime responsibility for the project.

   BC - Biology-Chemistry
   BL - Boundary Layer
   EB - Energy Budget
   ME - Lake Meteorology and Evaporation
   TW - Terrestrial Water Balance
   WM - Water Movement
   F - Feasibility

PREVIOUSLY COMPLETED PROJECTS

Project

1F: *Remote Sensing*

Principal Investigator: K.P.B. Thompson - CCIW

8EB: *Shore Gauging Stations of Water Temperature*

Principal Investigator: D.G. Robertson - CCIW

13TW: *Groundwater Flow into Lake Ontario*

Principal Investigator: D.H. Lennox - IWD

14TW: *Hydrology of Lake Ontario*

Principal Investigator: E.A. MacDonald - IWD

16ME: *Airborne Radiation Thermometer Survey*

Principal Investigator: J.G. Irbe - AES

18ME: *Climatological Network*

Principal Investigator: J.A.W. McCulloch - AES

20ME: *Bedford Tower Program*

Principal Investigators: J.A.W. McCulloch and D.W. Phillips - AES

21ME: *Canadian Shoreline Network*

Principal Investigator: J.A.W. McCulloch - AES

23ME: *Radar Precipitation*

Principal Investigator: D.M. Pollock - AES

24ME: *Climatological Studies*

Principal Investigator: D.W. Phillips - AES

25ME: *Lake Ontario Evaporation by Mass Transfer*

Principal Investigators: D.W. Phillips and J.G. Irbe - AES

27ME: *Island Precipitation Network*

Principal Investigator: J.A.W. McCulloch - AES

28BL: *Momentum, Heat, and Moisture Transfer*

Principal Investigators: G.A. McBean, H.C. Martin,
R.J. Polavarapu - AES

29BL: *Space and Time Spectra*

Principal Investigators: F.B. Muller and C.D. Holtz - AES

30F: *CCGS Porte Dauphine - IFYGL Operations*

Principal Investigator: G.K. Rodgers - CCIW

36EB: *Electronic Bathythermograph*

Principal Investigator: G.K. Rodgers - CCIW

38TW: *Groundwater*

Principal Investigator: R.C. Ostry - OME

40WM: *Coastal Chain Study*

Principal Investigator: G.T. Csanady - University of Waterloo

42EB: *Heat Storage of Lake Ontario*

Principal Investigator: F.M. Boyce - CCIW

43EB: *Internal Wave Measurements*

Principal Investigator: F.M. Boyce - CCIW

44BL: *Analysis of Energy Fluxes*

Principal Investigator: F.C. Elder - CCIW

46TW: *St. Lawrence-Niagara River Measuring Program*

Principal Investigator: M.H. Quast - IWD

49TW: *Snow Stratigraphy and Distribution*

Principal Investigator: W.P. Adams - Trent University

54BC: *Groundwater Supply Near Kingston*

Principal Investigator: W.A. Gorman - Queen's University

63ME: *Airborne Water Balance Study*

Principal Investigator: T.B. Kilpatrick - AES

65ME: *Special Shoreline Evaporation and Network*

Principal Investigator: J.A.W. McCulloch - AES

66ME: *Basin Evapotranspiration*

Principal Investigator: H.L. Ferguson - AES

67ME: *Surface Water Temperature Distribution*

Principal Investigator: M.S. Webb - AES

70WM: *Ground Truth for Remote Sensing*

Principal Investigator: A. Falconer - Univ. of Guelph

71EB: *Canadian Radiation Network*

Principal Investigator: J.A.W. McCulloch - AES

72EB: *Floating Ice Research*

Principal Investigator: R.O. Ramseier - DOE, Ice

73EB: *Terrestrial Heat Flow*

Principal Investigator: A. Judge - EM&R

74TW: *Water Level Network*

Principal Investigator: G.C. Dohler

75BL: *Wind and Temperature Fluctuations*

Principal Investigators: S.D. Smith and E.C. Banke - Bedford Institute

76WM: *Surface Wave Studies*

Principal Investigator: G.L. Holland - MSD

79F: *Bathymetric Surveys of Lake Ontario*

Principal Investigator: T.D.W. McCulloch - CCIW

80EB: *IFYGL Radiation Balance Program*

Principal Investigator: J.A. Davies - McMaster University

81BC: *Materials Balance - Lake Ontario*

Principal Investigator: S. Salbach - OME

82BC: *Lake Ontario Zooplankton Migration*

Principal Investigator: J.C. Roff - University of Guelph

94: *Data Retransmission by Satellite*

Principal Investigator: H. MacPhail - CCIW

95WM: *Hydrodynamic Modelling*

Principal Investigator: T.J. Simons - CCIW

97BL: *Meteorological Buoy Measurements*

Principal Investigator: F.C. Elder - CCIW

98BC: *Lake Ontario Cross Section Study*

Principal Investigator: M. Munawar - CCIW

101BC: *Lake Ontario Primary Production Study*

Principal Investigators: M. Munawar and J.E. Moore

102BC: *Lake Ontario Diel Pigment Variation*

Principal Investigators: W. Glooschenko and M. Munawar - CCIW

103BC: *Pesticide Concentration in Bird's Eggs*

Principal Investigator: M. Gilbertson - CWS

107BL: *Air Pollution Sinks*

Principal Investigator: D.M. Whelpdale - AES

108BL: *Lake Level Transfer*

Principal Investigator: G.C. Dohler - MSD

110WM: *Hydro Intake Study*

Principal Investigator: A. Arajs - OH

111WM: *Lakeview Dispersion Study*

Principal Investigator: M.D. Palmer - OME

115WM: *Wave Climatology*

Principal Investigator: H.K. Cho - CCIW

116TW: *Airborne Gamma Ray Snow Survey*

Principal Investigator: H.S. Loijens - IWD, Glaciology

117ME: *APT Photographs*

Principal Investigator: J.A.W. McCulloch - AES

118: *Canadian IFYGL Data Bank*

Principal Investigator: J. Byron - CCIW

ACTIVE PROJECTS

5BL: *Direct Measurement of Energy Fluxes*

Principal Investigator: M. Donelan - CCIW

Analysis of turbulence is continuing with a view towards establishment of flux-gradient relationships.

11TW: *Monthly Water Balance of Lake Ontario Basin*

Principal Investigator: D.F. Witherspoon - IWD, Cornwall

This project is complete. A final report will be incorporated into the Terrestrial Water Balance section of "IFYGL: A Scientific Summary of the International Field Year for the Great Lakes" to be published in 1978.

12TW: *Monthly Water Balance of Lake Ontario*

Principal Investigator: D.F. Witherspoon - IWD, Cornwall

This project is complete. A final report will be incorporated into the Terrestrial Water Balance section of "IFYGL: A Scientific Summary of the International Field Year for the Great Lakes" to be published in 1978.

15BL: *Space Spectra in the Free Atmosphere*

Principal Investigators: G.A. McBean and E.G. Morrissey - AES

This project is inactive. Most of the IFYGL objectives have been met. It is possible some further work will be done later on the data set.

22ME: *Synoptic Studies*

Principal Investigators: R.F. Cake and D.W. Phillips - AES

Work on this project continues with investigation of the May 26-29, 1972 lake/land breeze situation.

26ME: *Over-Water Climatological Ratios*

Principal Investigators: D.W. Phillips and J.G. Irbe - AES

This project is complete. A paper, "Lake to Land Comparison of Wind, Temperature, and Humidity of Lake Ontario During the International Field Year on the Great Lakes (IFYGL)", by D.W. Phillips and J.G. Irbe, has been published as an AES internal publication.

32EB: *Thermal Bar Study*

Principal Investigator: G.K. Rodgers - CCIW

Last report, Bulletin No. 19.

34WM: *Circulation Near Toronto*

Principal Investigator: G.K. Rodgers - CCIW

Last report, Bulletin No. 19.

45WM: *Lake Current Measurements*

Principal Investigator: E.B. Bennett - CCIW

This project is complete. The results will be included in the Water Movements section of "IFYGL: A Scientific Summary of the International Field Year for the Great Lakes" to be published in 1978.

62ME: *Evaporation Synthesis*

Principal Investigator: H.L. Ferguson - AES

This project is complete. The results will be included in the Evaporation Synthesis section of "IFYGL: A Scientific Summary of the International Field Year for the Great Lakes" which will be published in 1978.

64ME: *Atmospheric Water Balance Study*

Principal Investigator: H.L. Ferguson - AES

This project is complete. The results will be included in the Atmospheric Water Balance section of "IFYGL: A Scientific Summary of the International Field Year for the Great Lakes" which will be published in 1978.

68F: *CCIW Supporting Resources*

Principal Investigator: P.G. Sly - CCIW

Continues.

69TW: *Pleistocene Mapping*

Principal Investigator: M. Lewis - GSC

Last report, Bulletin No. 19.

83BC: *Cooperative Studies of Fish Stocks*

Principal Investigator: W.J. Christie - OMNR

This project is complete. The results will be included in the Status of the Biota section of "IFYGL: A Scientific Summary of the International Field Year for the Great Lakes" which will be published in 1978.

84BC: *Cladophora Growth*

Principal Investigator: G.E. Owen - OME

Data not in Data Bank. Analysis not likely to be completed.

85BC: *Nutrient Cycles - Lake Ontario*

Principal Investigator: A.S. Fraser - CCIW

This project is complete. The results are included in the Materials Balance section of "IFYGL: A Scientific Summary of the International Field Year for the Great Lakes" which will be published in 1978.

86BC: *Lake Ontario Surface Plankton Study*

Principal Investigator: H.F. Nicholson - CCIW

No report available. See Bulletin No. 12 for last report.

89WM: *Turbulent Diffusion Studies*

Principal Investigator: C.R. Murthy - CCIW

This project is complete. The final report, "Nearshore Diffusion Studies", by C.R. Murthy and K.C. Miners, is published elsewhere in this Bulletin.

104BC: *Rain Quality Monitoring*

Principal Investigator: M. Shiomi - CCIW

This project is continuing in modified form as part of an overall Great Lakes project related to Great Lakes Water Quality Surveillance. To date a total of 8 years of data have been accumulated from the Lake Ontario basin.

109WM: *Upwelling Study*

Principal Investigator: G.K. Rodgers - CCIW

Last report, Bulletin No. 19.

All other projects have either been withdrawn due to lack of sufficient funds or changes in personnel, or have been incorporated into one of the projects listed above.

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